



United States Department of the Interior
Fish and Wildlife Service

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In Reply Refer To:

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June 17
~~April 17~~, 1998

AB

MEMORANDUM

TO: Field Manager, Tucson Field Office, Bureau of Land Management, Tucson, Arizona

FROM: Acting Field Supervisor

SUBJECT: Biological Opinion on Reintroduction of Beaver into the San Pedro Riparian National Conservation Area

The U.S. Fish and Wildlife Service has reviewed the biological evaluation (with amendment) for the proposed reintroduction of beaver into the San Pedro Riparian National Conservation Area, located in Cochise County, Arizona. All information was received and consultation initiated on October 7, 1997. This document represents the Service's biological opinion on the effects of the proposed action on the southwestern willow flycatcher (*Empidonax traillii extimus*) and Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*) in accordance with section 7 of the Endangered Species Act of 1973, as amended, (16 U.S.C. 1531 et seq.). The Service appreciates your patience with our lack of timeliness in providing this biological opinion due to heavy workloads and staffing changes.

This biological opinion is based on information provided in the biological evaluation and subsequent amendment to that evaluation, information transmitted by facsimile, telephone conversations, field investigations, and other sources of information. A complete administrative record of this consultation is on file in the Arizona Ecological Services Field Office, Phoenix, Arizona.

Consultation history

The BLM notified the Service of the proposal to re-establish the beaver into the San Pedro National Riparian Conservation Area in April 1995. The Service replied on May 25, 1995, expressing concerns about the proposal and informing the BLM that formal consultation would be necessary for the southwestern willow flycatcher and other listed species. In July 1995, the BLM requested a threatened and endangered species list for the action area, and the Service provided this list in August 1995. A draft biological evaluation for the re-establishment of beaver was received by the Service on April 15, 1996. The Service replied with a draft pre-decisional document on May 28, 1996. The Service received a biological evaluation (BE) on November 26, 1996. Heavy workloads, continued work on listing packages, and staffing

changes in the Service's Phoenix office precluded preparation of a biological opinion at the time the BE was received; on December 26, 1996, the Service informed the BLM that formal consultation would not be initiated until February 1997. On January 30, 1997, the Service received a request from the BLM to include the recently-listed Huachuca water umbel in the formal consultation. Throughout, Mark Fredlake (BLM) has kept Angie Brooks (Service) informed of his discoveries of Huachuca water umbel colonies in the proposed re-introduction area.

On April 7, 1997, a meeting was held at the Service offices in Phoenix, Arizona. In attendance were: Angie Brooks and Rob Marshall (Service); Tony Herrell, Jeff Simms, Dave Krueper, and Mark Fredlake (BLM); and John Phelps and Mike Pruss (Arizona Game and Fish Department). Concerns addressed during the meeting included: evaluation of beaver effects in general, possible migration of beaver into other watersheds, effects of beaver on potential for native fish recovery, and effects of beaver on southwestern willow flycatchers. Other concerns were primarily limited to plans to monitor for changes to vegetation, fisheries, and avian communities to aid in evaluation of beaver effects.

On September 2, 1997, the Service received an addendum to the original BE; this addendum addressed issues discussed during the April, 1997, meeting. The Service replied to BLM, acknowledging receipt of this amended BE on October 7, 1997, and giving a timeline for completion of the biological opinion. On October 28, 1997, Bob Reed (Service) visited the proposed reintroduction site with Mark Fredlake and Bill Childress (BLM); topics discussed while investigating the site included amount of suitable habitat for southwestern willow flycatcher, vegetation monitoring protocols, and effects of beaver on streamflow and groundwater levels.

Description of proposed action

Beaver capture and release

The San Pedro Riparian National Conservation Area was established by Congress in 1989. Its purpose is to conserve, protect, and enhance the riparian ecosystem and associated wildlife, recreation, cultural, and watershed values. As part of this mission, the San Pedro Habitat Management Plan was developed, in cooperation with Arizona Game and Fish Department, to provide specific guidance for management of terrestrial and aquatic habitat. One main objective of this plan was to promote improvement of aquatic habitat and improve the stability of riparian streambanks within the conservation area. The establishment of beaver was proposed to help in achieving this objective.

Fifteen beaver will be captured from a suitable source. If possible, entire family groups will be captured and transplanted to preserve pair bond integrity. Possible capture sites include the middle Gila River, the Verde River, or the Salt River. Captured animals will be examined for *Giardia* infestation. Beaver will be released as male/female pairs or family groups in the mainstem San Pedro River between the Hereford Bridge and the Highway 90 Bridge, Cochise

County, Arizona. Releases will be made a minimum of one river mile apart. Movements and dispersal of beaver throughout the ecosystem will be monitored through the use of radiotelemetry. All captured beaver will be equipped with radio transmitters as funding allows.

Monitoring

The following studies will be conducted to document the impact of beaver on various aspects of the riparian ecosystem:

1. Line Intercept/Point Intercept Transects

Trends in streambank vegetation will be monitored periodically using existing transects. Additional transects will be established if funding can be gained from outside grants, and volunteers will be solicited to assist in data collection.

In addition, five stratified sampling areas will be established within the beaver transplant area. Within each sampling area belt and line transects will be established to monitor tree and shrub canopy cover, tree and shrub stem density, plant species composition, and tree DBH (diameter at breast height). Techniques used are found in Hays et al. (1981) and Interagency technical reference - sampling vegetation attributes (USDA, USDI, 1996). Piezometer and sediment arrays will be nested within belt transects to monitor alluvial groundwater levels and rates of sediment deposition. Stream flow measurements will be taken at biweekly intervals at each sampling area using a Marsh-McBurney flow meter.

Five sampling areas will be established at active beaver colonies once the release of beaver has occurred. Paired sampling of data (as above) will be performed at each location for comparison with control sites. Sampling will be performed at a level sufficient to draw statistically valid comparisons between beaver-influenced sites and those not influenced by the species. If an adequate pair is not present from the stratified random sampling areas, then additional sampling areas will be selected at random so that paired comparisons can be made.

2. Aquatic Habitat and Fisheries

Changes in stream and aquatic habitat will be monitored by BLM San Pedro Project Office staff, using methods developed by McCain *et al.* (1990). Two sites will be selected within the release area, one influenced by beaver activity and one where beaver are absent, as a control. Data will be compared graphically to assess apparent trends in aquatic habitat diversity. Additional paired sites will be added to assess variability and statistical significance if funding can be acquired from outside sources. Volunteers will be solicited to assist in data collection.

Fisheries sampling, using electro-shocking and seines, will be performed at Hereford Bridge, Highway 90, and Charleston in cooperation with USFWS and Bureau of Reclamation. An additional site will be surveyed in an area where beaver are active. Apparent trends in fish species diversity will be assessed by graphically comparing the site influenced by beaver with

the control area where beaver are absent. Additional sites will be monitored if funding is available from outside sources. Volunteers will be solicited to assist in data collection.

Additional monitoring is proposed to address the following management questions:

- (1) Do beaver dams change the species composition of the fish community, favoring non-native fishes detrimental to native fish management?
- (2) Do beaver dams influence the total numbers and biomass of fish, especially non-native fishes detrimental to native fishes?
- (3) Does beaver activity change the composition of various meso-habitat types (run, riffle, pool)? Do these changes favor non-native fishes? Do these changes cause shifts in habitat composition to the detriment of future success of spikédace and loach minnow reintroduction efforts?

Fish will be collected behind beaver dams using electrofishing gear and 1/8 inch mesh seines; three passes will be completed in each pool. Fish will be held alive in aerated containers, identified to species, batch weighed by species, enumerated by species, classified to live stage by species (adult or juvenile), and released at the site of capture. Up to five ponds will be sampled annually in the fall for five years.

A reach removed from the backwater influence of the beaver dam will be selected and sampled using electrofishing gear and seines. The site will be selected based on the abundance of large pool habitat created by hydraulic channel dynamics. Comparisons between the beaver ponds and pools formed by scour will be compared on a linear distance and volume basis. Physical habitat variables for each site will be measured and recorded, including: habitat type, length, average width, average depth, maximum depth, substrate composition, submerged cover, overhanging cover, undercut bank, emergent vegetation, etc. Physical habitat for spikédace and loach minnow will be further evaluated for relative suitability using computer modeling of depth, velocity and substrate parameters. Reaches with beaver influence and those without will be compared for relative habitat similarity using PHABSIM (Milhous et al. 1989) at 2 discharges: low summer flow and high winter base discharge. Physical data (velocity, depth, substrate) will be collected at the two discharges and a weighted usable area (WUA) determined for areas with beaver activity and those without. WUA will be used as the primary determinant for habitat suitability.

A statistically valid sample may not be available due to the low initial density of beaver. However, the variability between beaver ponds will be computed and presented as standard error. Areas with beaver activity will be compared to those areas remote from beaver. Fish community characteristics will be tabulated for species composition, relative abundance, total numbers by species and biomass by species. Habitat features including WUA will be compared. An analysis of relative habitat potential between areas with beaver and those without will be completed for spikédace and loach minnow.

3. Habitat Use and Dispersal Monitoring

Beaver habitat use and dispersal will be monitored by Arizona Game and Fish Department personnel, utilizing radiotelemetry and ground surveys. Each beaver will be equipped with a sub-cutaneous radio-transmitter, and aerial surveys will be conducted monthly to locate individuals. On-the-ground follow-up surveys will be conducted to document presence of beaver and observable changes in vegetation and other factors. Batteries in these transmitters last two to three years. Beaver will probably establish territories in the first year, after which they remain in a fairly defined area for the remainder of their lives. Hence, radio-telemetry will effectively document the dispersal of beaver during the initial release. If additional funding becomes available, dispersal of progeny can be studied using radiotelemetry, thus providing information on dispersal of juveniles from established colonies.

4. Groundwater Monitoring

Groundwater levels near the stream will be monitored by BLM personnel using existing monitoring wells where baseline data have been collected since 1988. This will provide apparent trends in groundwater attributable to beaver and determine whether beaver activity increases water storage in the alluvial aquifer. If funding is available, additional wells will be installed in the floodplain in the vicinity of beaver activity. Installation will occur after beaver release since the exact points of beaver colonization cannot be determined in advance. Volunteers will be solicited to assist in this task.

5. Streamflow Data

Streamflow measurements will be taken at Hereford Bridge, Highway 90 Bridge, and 2 miles south of Highway 90 at Cottonwood well by BLM San Pedro Project Office staff, to determine changes in summer stream flow relative to beaver modification of riparian zones. Baseline data have been collected almost continuously at these points since 1988.

6. Beaver Effects Monitoring

Beaver effects on the avian community will be monitored by BLM personnel using point count transects. Baseline data have been gathered over the past nine years at Highway 90 and Hereford Bridge. If beaver do not colonize these sites, then they will serve as control sites and an additional transect will be established to monitor avian response to beaver activity. Trends in avian populations relative to beaver will be assessed using graphic comparisons between beaver-influenced site and control site. Once beaver have become established in one area, biologists will continue to census the area, as well as initiate an additional point count survey in an area adjacent, but similar (in terms of vegetation structure) to the study site. Additional transects will be installed if funding becomes available through outside grants. Volunteers will be solicited to assist in this task. An annual raptor census will be conducted to monitor gray hawk nesting pairs. Apparent trend in gray hawk populations relative to beaver will be assessed by comparing nesting success prior to beaver release with success after release.

Currently, southwestern willow flycatcher surveys are being conducted within appropriate breeding habitat throughout the length of the NCA. These surveys have used the standardized protocol as described by Sogge et al. (1997), and have been conducted in 1995, 1996, and 1997. These surveys will continue after beaver are released.

7. Mosquito Regulation Sampling

Mosquito populations will be sampled to detect changes relative to beaver activity at four stations along the river and at three sites outside the NCA in cooperation with the Arizona Department of Health Service.

8. Huachuca Water Umbel Monitoring

The distribution of the Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*) will be monitored through time to determine whether the species expands or diminishes in response to beaver activity. Colonies of water umbel are identified and located using aerial photos and 7.5 minute topographic maps.

Evaluation of the effects of beaver re-establishment

Evaluations of the effects of beaver on the San Pedro ecosystem will be performed at one, two, and five year intervals after the initial release, and every five years thereafter. This schedule notwithstanding, local control of beaver effects can be initiated at any time when adverse effects or damage are documented. On private land and public land these control measures can include non-lethal trapping and relocation, fencing and/or caging of sensitive areas or plants, installation of Clemson dam levelers or other leveling devices in beaver dams, caging of culverts, etc. Lethal trapping is not permitted on Arizona public lands but is permissible on private lands.

The need for control of beaver throughout the project area will be evaluated using a scorecard system similar to that employed by Arizona Game and Fish Department for non-game re-establishments. This method will be instituted because no single factor has yet been found to be an adequate indicator of the need for beaver control. The project area is defined as the area within the boundary of the San Pedro Riparian National Conservation Area. See the amended Biological Evaluation for a list of categories to be evaluated.

STATUS OF THE SPECIES (rangewide)

Southwestern willow flycatcher

The southwestern willow flycatcher is a small passerine bird (Order Passeriformes; Family Tyrannidae) measuring approximately 15 centimeters (5.75 inches) in length from the tip of the bill to the tip of the tail and weighing only 11 grams (0.4 ounces). It has a grayish-green back and wings, whitish throat, light gray-olive breast, and pale yellowish belly. Two white wingbars

are visible (juveniles have buffy wingbars). The eye ring is faint or absent. The upper mandible is dark, the lower is light yellow grading to black at the tip.

The southwestern willow flycatcher is an insectivore typically perching on a branch and making short direct flights, or sallying, to capture flying insects. The southwestern willow flycatcher is a riparian obligate, nesting along rivers, streams, and other wetlands where dense growths of willow (*Salix* sp.), *Baccharis*, buttonbush (*Cephalanthus* sp.), boxelder (*Acer negundo*), saltcedar (*Tamarix* sp.) or other plants are present, often with a scattered overstory of cottonwood (*Populus* sp.) and/or willow.

One of four currently-recognized willow flycatcher subspecies (Phillips 1948, Unitt 1987, Browning 1993), the southwestern willow flycatcher is a neotropical migratory species that breeds in the southwestern U.S. and migrates to Mexico, Central America, and possibly northern South America during the non-breeding season (Phillips 1948, Stiles and Skutch 1989, Peterson 1990, Ridgely and Tudor 1994, Howell and Webb 1995). The historical range of the southwestern willow flycatcher included southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja; Unitt 1987).

The States of California and New Mexico list the southwestern willow flycatcher as endangered (California Department of Fish and Game 1992, and New Mexico Department of Game and Fish 1988). The State of Arizona considers the southwestern willow flycatcher a species of special concern (Arizona Game and Fish Department 1996). The Service included the southwestern willow flycatcher on its Animal Notice of Review as a category 2 candidate species on January 6, 1989 (USFWS 1989). A proposal to list the southwestern willow flycatcher as endangered, with critical habitat, was published on July 23, 1993 (United States Fish and Wildlife Service 1993), and a final rule without critical habitat was published on February 27, 1995 (USFWS 1995), becoming effective on March 29, 1995. Following the review of comments received during the public comment period, the Service deferred the designation of critical habitat, invoking an extension on this decision until July 23, 1995. A moratorium on listing actions under the Act passed by Congress in April 1995 required the Service to cease work on the designation of critical habitat. On April 26, 1996, the moratorium was lifted and on May 16, 1996, the Service published a notice in the Federal Register announcing listing prioritization guidance. Listing actions were placed in categories of decreasing order of priority: Tier 1 - Emergency listings; Tier 2 - Finalization of listing decisions on proposed species; and Tier 3 - all other listing actions (proposed rules, petition findings, critical habitat designations). On May 15, 1996, the Southwest Center for Biological Diversity filed a lawsuit claiming that the Service violated the Act by not finalizing critical habitat for the southwestern willow flycatcher. On March 20, 1997, the District Court ordered the Service to finalize critical habitat for the flycatcher by July 18, 1997. As ordered, the critical habitat was published on July 18, 1997, and became effective on August 21, 1997. A correction notice was published in the Federal Register on August 20, 1997.

Life History

The southwestern willow flycatcher forages within and above dense riparian vegetation, taking insects on the wing or gleaning them from foliage (Wheelock 1912, Bent 1963). No information is available on specific prey species. However, fecal samples containing identifiable invertebrate body parts were collected during banding operations from more than 70 southwestern willow flycatchers in California, Arizona, and southwestern Colorado (M. Sogge, pers. comm.). These samples could yield important data on prey use at various locations and timing throughout the breeding season.

The southwestern willow flycatcher begins arriving on breeding grounds in late April and May (Sogge and Tibbitts 1992, Sogge *et al.* 1993, Sogge and Tibbitts 1994, Muiznieks *et al.* 1994, Maynard 1995, Sferra *et al.* 1995). Migration routes are not completely known. However, willow flycatchers have been documented migrating through specific locations and drainages in Arizona that do not currently support breeding populations, including the upper San Pedro River (BLM, unpubl. data), Colorado River through Grand Canyon National Park (Sogge and Tibbitts 1992, Sogge *et al.* 1993, Sogge and Tibbitts 1994), lower Colorado River (Muiznieks *et al.* 1994, Spencer *et al.* 1996), Verde River tributaries (Muiznieks *et al.* 1994), and Cienega Creek (BLM, *in litt.*). These observations probably include subspecies *E. t. brewsteri* and *E. t. adastus*. *Empidonax* flycatchers rarely sing during fall migration so a means of distinguishing some migrating *Empidonax* without a specimen is not feasible (Blake 1953, Peterson and Chalif 1973). However, willow flycatchers have been reported to sing and defend winter territories in Mexico and Central America (Gorski 1969, McCabe 1991).

Nesting begins in late May and early June and young fledge from late June through mid-August (Willard 1912, Ligon 1961, Brown 1988a,b, Whitfield 1990, Sogge and Tibbitts 1992, Sogge *et al.* 1993, Muiznieks *et al.* 1994, Whitfield 1994, Maynard 1995). Southwestern willow flycatchers typically lay three to four eggs in a clutch (range = 2-5). The breeding cycle, from laying of the first egg to fledging, is approximately 28 days. Eggs are laid at one-day intervals (Bent 1963, Walkinshaw 1966, McCabe 1991); they are incubated by the female for approximately 12 days; and young fledge approximately 12 to 13 days after hatching (King 1955, Harrison 1979). Southwestern willow flycatchers typically raise one brood per year but have been documented raising two broods during one season (Whitfield 1990). They have also been documented reneesting after nest failure (Whitfield 1990, Sogge and Tibbitts 1992, Sogge *et al.* 1993, Sogge and Tibbitts 1994, Muiznieks *et al.* 1994, Whitfield 1994, Whitfield and Strong 1995).

Whitfield, who has accumulated the largest data set on southwestern willow flycatchers, reported the following data on survivorship of adults and young: of 58 nestlings banded since 1993, 21 (36%) returned to breed; of 57 birds banded as adults (after hatch year) since 1989, 18 (31%) returned to breed at least 1 year (10 males, 8 females); 5 (9%) returned to breed for 2 years (all males); and 2 (3.5%) returned to breed for 3 years (M. Whitfield, Kern River Preserve, pers. comm.). Whitfield (1995) also documented statistically significant variation in return rates of juveniles as a function of fledging date; approximately 21.9% of juveniles fledged on or before

July 20th returned to her study area the following year, whereas only 6.4% of juveniles fledged after July 20th returned the following year.

Walkinshaw (1966), who studied *E.t. traillii* in Michigan, estimated that 40.9% of the males at his study site returned to breed for at least 2 years, 22.7% returned for at least 3 years, 13.6% returned for at least 4 years, and at least 4.5% returned during their year 5. Female return rates were substantially lower. Only 22.6% returned to breed for 1 year. Whitfield and Walkinshaw do not incorporate potential emigration rates into their estimates of returns and, thus, may underestimate actual survivorship. However, these data are consistent with survival rates for other passerines (Gill 1990, chap. 21) suggesting that the lifespan of most southwestern willow flycatchers is probably 2 to 3 years (i.e. most flycatchers survive to breed 1 or 2 seasons).

Brood parasitism of southwestern willow flycatcher nests by the brown-headed cowbird (*Molothrus ater*) has been documented throughout the flycatcher's range (Brown 1988a,b, Whitfield 1990, Muiznieks *et al.* 1994, Whitfield 1994, Hull and Parker 1995, Maynard 1995, Sferra *et al.* 1995, Sogge 1995b). Cowbirds lay their eggs in the nests of other species directly affecting their hosts by reducing nest success. Cowbird parasitism reduces host nest success in several ways. Cowbirds may remove some of the host's eggs, reducing overall fecundity. Hosts may abandon parasitized nests and attempt to reneest, which can result in reduced clutch sizes, delayed fledging, and reduced overall nesting success and fledgling survivorship (Whitfield 1994, Whitfield and Strong 1995). Cowbird eggs, which require a shorter incubation period than those of many passerine hosts, hatch earlier giving cowbird nestlings a competitive advantage over the host's young for parental care (Bent 1963, McGeen 1972, Mayfield 1977a,b, Brittingham and Temple 1983). Where studied, high rates of cowbird parasitism have coincided with southwestern willow flycatcher population declines (Whitfield 1994, Sogge 1995a, Sogge 1995c, Whitfield and Strong 1995), or, at a minimum, resulted in reduced or complete elimination of nesting success (Muiznieks *et al.* 1994, Whitfield 1994, Maynard 1995, Sferra *et al.* 1995, Sogge 1995a, Sogge 1995c, Whitfield and Strong 1995). Whitfield and Strong (1995) found that flycatcher nestlings fledged after July 20th had a significantly lower return rate and that cowbird parasitism was often the cause of delayed fledging.

Habitat Use

The southwestern willow flycatcher breeds in dense riparian habitats from sea level in California to over 7000 feet in Arizona and southwestern Colorado. Throughout its wide geographic and elevational range, its riparian habitat can be broadly described based on plant species composition and habitat structure (Sogge *et al.* 1997). These attributes are among the most conspicuous components of flycatcher habitat but not necessarily the only important components. They are easily identified from photographs or during field visits and have been useful in conceptualizing, selecting, and evaluating suitable survey habitat. Photographs and accompanying text provided in Sogge *et al.* (1997) characterize the considerable variation in habitat structure and plant species composition found at breeding sites throughout the southwestern willow flycatcher's range. Two components that vary less across this subspecies'

range are vegetation density and the presence of surface water. Those and other characteristics, such as size and shape of habitat patches, are described further below.

Based on the diversity of plant species composition and complexity of habitat structure, four basic habitat types can be described for the southwestern willow flycatcher. Those types are described below and should be referenced with photographs provided in Sogge *et al.* (1997). When reviewing the habitat descriptions below and applying them to a particular location in the field, keep in mind that characteristics of actual breeding sites fall somewhere on a continuum from monotypic to multiple plant species, and from a relatively simple habitat structure characterized by a single vegetation stratum to more complex habitat patches characterized by multiple-strata.

Monotypic willow: Nearly monotypic, dense stands of willow (often *S. exigua* or *S. geyeriana*) 3 to 7 meters in height with no distinct overstory layer; usually very dense structure in at least lower 2 m; live foliage density is high from the ground to canopy.

Monotypic exotic: Nearly monotypic, dense stands of exotics such as saltcedar (*Tamarisk* sp.) or Russian olive (*Elaeagnus angustifolia*) 4 to 10 m in height forming a nearly continuous, closed canopy (with no distinct canopy layer); lower 2 m may be very difficult to penetrate due to branch density; however live foliage volume may be relatively low from 1 to 2 m above ground; canopy density uniformly high.

Native broadleaf dominated: Comprised of dense stands of single species (often Goodding's or other willows) or mixtures of native broadleaf trees and shrubs including, but not limited to, cottonwood, willows, boxelder, ash, buttonbush, and stinging nettle from 4 to 15 m in height; characterized by trees of different size classes; may have distinct overstory of cottonwood, willow or other broadleaf species, with recognizable subcanopy layers and a dense understory of mixed species; exotic/introduced species may be a rare component, particularly in understory.

Mixed native/exotic: Dense mixtures of native broadleaf trees and shrubs (such as those listed above) mixed with exotic species such as tamarisk and Russian olive; exotics are often primarily in the understory, but may also be a component of overstory; the native and exotic components may be dispersed throughout the habitat or concentrated as a distinct patch within a larger matrix of habitat; overall, a particular site may be dominated primarily by natives, exotics, or be a more or less equal mixture.

There are other potentially important dimensions or characteristics of southwestern willow flycatcher habitat, including: size, shape, and distribution of vegetation patches; hydrology; prey types and abundance; parasites; predators; environmental factors (e.g. temperature, humidity); and interspecific competition. Underlying these are factors relating to population dynamics, such as demography (i.e. birth and death rates, age-specific fecundity), the distribution of breeding groups across the landscape, flycatcher dispersal patterns, migration routes, site fidelity, philopatry, and degree of conspecific sociality (e.g. coloniality). Most of these attributes are not well understood for the southwestern willow flycatcher. However, some of these factors

may be critical to understanding current population dynamics and habitat use. For example, characterizations of suitable breeding habitat may be significantly biased if observed patterns of habitat use are influenced by intrinsic dispersal patterns and capabilities rather than overall habitat quality.

Ultimately, habitat suitability should be measured in terms of reproductive success and survivorship that result in a positive rate of population growth. Without long term data that correlate or experimentally verify which combination of the above attributes contribute to population growth, habitat descriptions should be viewed broadly and considered descriptors of "suitable survey habitat."

The size and shape of occupied riparian habitat patches vary considerably. Southwestern willow flycatchers have been found nesting in patches as small as 0.8 hectares (*e.g.* Grand Canyon) and as large as several hundred hectares (*e.g.* Roosevelt Lake, Lake Mead). When viewed from above, the mixed vegetation types in particular often appear as a mosaic of plant species and patch shapes and sizes. In contrast, narrow, linear riparian habitats one or two trees wide do not appear to contain attributes attractive to nesting flycatchers. However, flycatchers have been found using these habitats during migration.

Open water, cienegas, marshy seeps, or saturated soil are typically in the vicinity of flycatcher territories and nests; flycatchers sometimes nest in areas where nesting substrates were in standing water (Maynard 1995, Sferra *et al.* 1995, 1997). However, hydrological conditions at a particular site can vary remarkably in the arid Southwest within a season and between years. At some locations, particularly during drier years, water or saturated soil is only present early in the breeding season (*i.e.* May and part of June). However, the total absence of water or visibly saturated soil has been documented at several sites where the river channel has been modified (*e.g.* creation of pilot channels), where modification of subsurface flows has occurred (*e.g.* agricultural runoff), or as a result of changes in river channel configuration after flood events (Spencer *et al.* 1996).

Nest placement and nesting substrate

Southwestern willow flycatcher nests are open cup structures, approximately 8 centimeters high and 8 centimeters wide (outside dimensions), exclusive of any dangling material at the bottom. Nests are typically placed in the fork of a branch with the nest cup supported by several small-diameter vertical stems. The main branch from which the fork originates may be oriented vertically, horizontally, or at an angle, and stem diameter for the main supporting branch can be as small as three to four cm. Vertical stems supporting the nest cup are typically one to two cm in diameter. Occasionally, southwestern willow flycatchers place their nests at the juncture of stems from separate plants, sometimes different plant species. Those nests are also characterized by vertically-oriented stems supporting the nest cup. Spencer *et al.* (1996) measured the distance between flycatcher nests and shrub/tree center for 38 nests in monotypic saltcedar and mixed native broadleaf/saltcedar habitats. In monotypic saltcedar stands ($n=31$),

nest placement varied from 0.0 m (center stem of shrub or tree) to 2.5 m. In the mixed riparian habitat (n=7), nest placement varied from 0.0 to 3.3 m.

Nest height relative to the base of nest substrate also varies across the southwestern willow flycatcher's range and may be correlated with height of nest substrate and/or overall canopy height. Table 3 body for 1 presents data on nest heights in different riparian habitat types across the flycatcher's range. Southwestern willow flycatcher nests have been found as low as 0.6 m above the ground to 14 m above the ground. The data presented in Table 1 demonstrate that flycatchers using predominantly native broadleaf riparian habitats nest relatively low to the ground (between 1.8 m and 2.1 m on average), whereas those using mixed native/exotic and monotypic exotic riparian habitats nest relatively high above the ground (between 4.3 m and 7.4 m on average).

Historic egg/nest collections and species' descriptions from throughout the southwestern willow flycatcher's range confirm the bird's widespread use of willow for nesting (Phillips 1948, Phillips *et al.* 1964, Hubbard 1987, Unitt 1987, T. Huels *in litt.* 1993, San Diego Natural History Museum 1995). Of the 34 nests found by Brown in 1902 near Yuma on the lower Colorado and Gila rivers, 33 were in Goodding's willow and one was in arrowweed. Data from historic egg collections from southern California and more current studies indicate that 75 to 80% of nests were placed in willows (San Diego Natural History Museum 1995).

Currently, southwestern willow flycatchers use a wide variety of plant species for nesting substrates. At the monotypic willow stands that characterize high elevation sites in Arizona, Geyer willow was used almost exclusively for nesting (Muiznieks *et al.* 1994). At the inflow to Lake Mead on the Colorado River, Goodding's willow was the primary nesting substrate (R. McKernan unpubl. data). Along a 20-mile stretch of the Gila River in Grant County, New Mexico, where boxelder is the dominant understory species, 76% of flycatcher nests were placed in boxelder, with the remainder in Russian olive and saltcedar (Skaggs 1996). At the inflows of Tonto Creek and Salt River to Roosevelt Lake in Gila County, Arizona, both of which are comprised of monotypic stands of saltcedar, 100% of flycatcher nests were placed in saltcedar (Muiznieks *et al.* 1994, Sferra *et al.* 1995, Spencer *et al.* 1996). On the San Luis Rey River in San Diego County, California, approximately 90% of flycatcher nests were placed in live oak (*Quercus agrifolia*), which became the dominant plant species adjacent to the stream after willows were removed in the 1950s as a water conservation measure and a reservoir upstream reduced flood frequency and streamflow volume (W. Haas, San Diego Natural History Museum, pers. comm., 1995). Other plant species that southwestern willow flycatcher nests have been documented in include: buttonbush, black twinberry (*Lonicera involucrata*), Fremont cottonwood, white alder (*Alnus rhombifolia*), blackberry (*Rubus ursinus*), Russian olive, and *S. hindsiana*.

Territory size

Southwestern willow flycatcher territory size, as defined by song locations of territorial birds, probably changes with population density, habitat quality, and nesting stage. Early in the

season, territorial flycatchers may move several hundred meters between singing locations (Sogge *et al.* 1995, Petterson and Sogge 1996). It is not known whether these movements represent polyterritorial behavior or active defense of the entire area encompassed by singing locations. However, during incubation and nestling phases territory size, or at least the activity centers of pairs, can be very small and restricted to an area less than 0.5 hectare. Sogge *et al.* (1995) estimated a breeding territory size of 0.2 hectares for a pair of flycatchers occupying a 0.6-hectare patch on the Colorado River. Activity centers may expand after young are fledged but while still dependent on adults.

Distribution and abundance

Unitt (1987) noted that taxonomic confusion between *E. trailli* and *E. alnorum* (alder flycatcher) and among other *Empidonax* species that migrate through the southwestern U.S. probably accounted for the relative lack of research on the southwestern willow flycatcher. The alder and willow flycatchers, formerly known as Traill's flycatcher, were not officially recognized as separate species until the American Ornithologist's Union published its sixth edition Checklist of North American Birds (American Ornithological Union 1983). The lack of systematic, range-wide collections of southwestern willow flycatchers preclude a complete description of this subspecies' former distribution and abundance. However, the more than 600 egg, nest, and specimen records available from museums throughout the U.S. in combination with state, county, and local faunal accounts from the first half of the 20th Century do indicate that, historically, the southwestern willow flycatcher was more widespread and, at least, locally abundant.

Phillips (1948) first described *E.t. extimus* from a specimen collected by Gale Monson on the lower San Pedro River near Feldman, Arizona. The taxonomic validity of *E.t. extimus* was subsequently reviewed by Hubbard (1987), Unitt (1987), and Browning (1993), and has been accepted by most authors (e.g., Aldrich 1951, Behle and Higgins 1959, Phillips *et al.* 1964, Oberholser 1974, Monson and Phillips 1981, Harris *et al.* 1987a,b, Schlorff 1990a,b, Harris 1991). Unitt (1987) reviewed historical and contemporary records of *E.t. extimus* throughout its range, determining that it had "declined precipitously..." and that although the data reveal no trend in the past few years, the population is clearly much smaller now than 50 years ago, and no change in the factors responsible for the decline seem likely.

Overall, Unitt (1987) documented the loss of more than 70 breeding locations rangewide, including locations along the periphery and within core drainages that form this subspecies' range. Unitt estimated that, rangewide, the southwestern willow flycatcher population probably was comprised of 500 to 1000 pairs. Below is a state by state comparison of historic and current data for the southwestern willow flycatcher. Since 1992 more than 800 historic and new locations have been surveyed rangewide to document the status of the southwestern willow flycatcher (some sites in southern California have been surveyed since the late 1980s). Survey efforts in most states were done under the auspices of the Partners In Flight program, which served as the coordinating body for collection and synthesis of data. The extensive and, in some

cases, intensive nature of these efforts have provided a critical baseline for the current distribution, abundance, and reproductive success of southwestern willow flycatchers rangewide.

California

The historic range of southwestern willow flycatchers in California apparently included all lowland riparian areas in the southern third of the state. It was considered a common breeder where suitable habitat existed (Wheelock 1912, Willett 1912, 1933, Grinnell and Miller 1944). Unitt (1984, 1987) concluded that it was once common in the Los Angeles basin, the San Bernardino/Riverside area, and San Diego County. Specimen and egg/nest collections confirm its former distribution in all coastal counties from San Diego Co. to San Luis Obispo Co., as well as in the inland counties, Kern, Inyo, Mohave, San Bernardino, and Imperial. Unitt (1987) documented that the flycatcher had been extirpated, or virtually extirpated (i.e., few territories remaining) from the Santa Clara River (Ventura Co.), Los Angeles River (Los Angeles Co.), Santa Ana River (Orange and Riverside counties), San Diego River (San Diego Co.), lower Colorado River (Imperial and Riverside counties and adjacent counties in Arizona), Owen's River (Inyo Co.), and the Mohave River (San Bernardino Co.). Its former abundance in California is evident from the 72 egg and nest sets collected in Los Angeles County, alone, between 1890 and 1912, and from Herbert Brown's 34 nests and 9 specimens taken in June, 1902 from the lower Colorado River near Yuma. Local collections of this magnitude suggest that this subspecies was locally very abundant.

Survey and monitoring efforts since the late 1980s have confirmed the southwestern willow flycatcher's presence at 18 locations on 11 drainages in southern California (including Colorado River). Current known flycatcher breeding sites are restricted to 3 counties, San Diego, Riverside, Santa Barbara, and Kern. Combining survey data for all sites surveyed since the late 1980s for a composite population estimate, the total known southwestern willow flycatcher population in southern California is 114 territories (Table 2). Of the 18 sites where flycatchers have been documented, 72% (13) contain 5 or fewer territorial flycatchers; 22% (4 sites) have single pairs, or unmated territorial birds. Only 3 drainages are known to have 20 or more flycatcher territories, the San Luis Rey River (San Diego Co.), South Fork Kern River (Kern Co.), and Santa Ynez River (Santa Barbara Co.).

Authorized (permitted) and unauthorized activities in riparian habitats continue to adversely affect occupied flycatcher habitat in southern California. For example, approximately one kilometer of occupied habitat on the Santa Ynez River in Santa Barbara County was modified or completely eliminated in 1996 when expansion of agricultural fields resulted in clearing of riparian vegetation (USFWS *in litt.*). Despite the vast potential for riparian habitat and southwestern willow flycatcher recovery on Camp Pendleton in San Diego County, a programmatic section 7 consultation resulted in a conservation target of 20 southwestern willow flycatcher pairs (Table 3). The Base currently has approximately 22 pairs of flycatchers, in contrast to the 348 pairs of the sympatric and endangered least Bell's vireo (*Vireo bellii pusillus*), which through the Base's conservation efforts increased from a low of 27 pairs in 1984. Army Corps of Engineers operations of Lake Isabella (Kern County) will result in long-

term inundation of the 485-ha South Fork Wildlife Area, also proposed critical habitat for the flycatcher. The Wildlife Area represents a significant recovery area occupied by 8 to 10 pairs of flycatchers prior to inundation and lies downstream of one of California's largest southwestern willow flycatcher breeding groups on the Kern River Preserve.

Arizona

Historic records for Arizona indicate the former range of the southwestern willow flycatcher included portions of all major river systems (Colorado, Salt, Verde, Gila, Santa Cruz, and San Pedro) and major tributaries, such as the Little Colorado River and headwaters, and White River. Unitt (1987) noted that "probably the steepest decline in the population levels of *extimus* has occurred in Arizona." The bird has been extirpated, or virtually extirpated from the Santa Cruz River (Pima Co.), upper San Pedro River (Cochise Co.), lower San Pedro River at PZ Ranch (Pinal Co.), Blue River (Greenlee Co.), Colorado River at Lees Ferry (Coconino Co.), Colorado River (Yuma Co.), Gila River (Yuma Co.), and Verde River at Tuzigoot Bridge (Yavapai Co.).

Currently, 150 territories are known from 39 sites along 9 drainages statewide, including the Colorado River (Table 2). As in California, the majority of breeding groups in Arizona are extremely small; of the 39 sites where flycatchers have been documented, 74% (29) contain 5 or fewer territorial flycatchers. Moreover, 15% to 18% of all sites in Arizona are comprised of single, unmated territorial birds.

Permitted activities and stochastic events also continue to adversely affect the distribution and extent of occupied and potential breeding habitat throughout Arizona. For example, the Bureau of Reclamation is operating the new conservation space at Roosevelt Lake, which at capacity would totally inundate the riparian stands occupied by Arizona's largest breeding group (Table 3). As a result of Reclamation's operations on the lower Colorado River, the 445-ha Goodding's willow stand at the inflow to Lake Mead has been partially inundated since September 1995. Despite partial inundation, approximately eight pairs of flycatchers were documented nesting at the inflow during the 1996 breeding season. As of April 1997, inundation of that habitat was nearly complete. The Bureau of Reclamation projected the mortality of that stand sometime during 1997 as a result of prolonged inundation of root crowns (i.e. > two growing seasons).

In June of 1996, a catastrophic fire destroyed approximately one km of occupied habitat on the San Pedro River in Pinal County. That fire resulted in the forced dispersal or loss of up to 8 pairs of flycatchers (Paxton *et al.* 1996). In June, 1995, approximately three miles of occupied riparian habitat burned on the Gila River in Pinal County (Bureau of Land Management *in litt.*). It is not known how many flycatchers occupied that location. Approximately two km of riparian habitat burned in Graham County in the vicinity of Safford during 1996. It is not known whether that area was occupied by southwestern willow flycatchers, however, it did lie just downstream of an occupied patch that was partially eliminated by Solomon Bridge (Table 3). The anticipated effect of construction of the Solomon Bridge was dispersal of flycatchers into

adjacent habitat. The capability of adjacent habitat to absorb that dispersal was compromised by the fire near Safford.

New Mexico

Unitt (1987) considered New Mexico as the state with the greatest number of *extimus* remaining. After reviewing the historic status of the flycatcher and its riparian habitat in New Mexico, Hubbard (1987) concluded,

[it] is virtually inescapable that a decrease has occurred in the population of breeding willow flycatchers in New Mexico over historic time. This is based on the fact that wooded sloughs and similar habitats have been widely eliminated along streams in New Mexico, largely as a result of the activities of man in the area.

Unitt (1987), Hubbard (1987), and more recent survey efforts have documented extirpation or virtual extirpation in New Mexico on the San Juan River (San Juan Co.), near Zuni (McKinley Co.), Blue Water Creek (Cibola Co.), Rio Grande (Dona Ana Co. and Socorro Co.). Survey and monitoring efforts since 1993 have documented 173 flycatcher territories on eight drainages (Table 2). Approximately 135 of these territories occur in remnant strips of riparian forest within a 20-mile stretch of the Gila River in Grant Co (Skaggs 1995). This area contains the largest known breeding group rangewide. In a letter responding to proposed critical habitat for the flycatcher, this part of the Gila River is characterized as being contained by flood-control levees that do not support the regeneration of riparian trees such as willow and cottonwood. Thus, under existing conditions, habitat suitable for the southwestern willow flycatcher is not regenerating and this largest population may be lost as a result. Outside of Grant County few flycatchers remain. Statewide, 84% (16) of the 19 sites with flycatchers contain 5 or fewer territorial birds. Six sites are comprised of single pairs or unmated territorial flycatchers, and six others are comprised of two pairs or two unmated territorial birds.

Texas

The Pecos and Rio Grande Rivers in western Texas are considered the easternmost boundary for the southwestern willow flycatcher. Unitt (1987) found specimens from four locations in Brewster, Hudspeth, and Loving counties where the subspecies is no longer believed to be present. Landowner permission to survey riparian areas on private property has not been obtained, thus current, systematic survey data is not available for Texas. There have been no other recent reports, anecdotal or incidental, of southwestern willow flycatcher breeding attempts in the portion of western Texas where they occurred historically. Given that surveys in adjacent Dona Ana County, New Mexico, have failed to document breeding along historically-occupied portions of the Rio Grande, the Service believes it is likely that the southwestern willow flycatcher has been extirpated from Texas.

Colorado

The taxonomic status and the historic distribution and abundance of willow flycatchers in southwestern Colorado remains unclear due to a lack of specimen data and breeding records. Preliminary data on song dialects suggests that the few birds recently documented in southwestern Colorado may be *E.t. extimus*. These sightings have prompted State and Federal agencies to delineate provisional boundaries for southwestern willow flycatchers and sponsor statewide survey efforts. Survey efforts since 1993 have documented a total of six locations in Delta, Mesa, and San Miguel counties where southwestern willow flycatchers have been found (Table 2). Two locations have single, unmated males; two locations have single pairs, and the remaining two locations are comprised of four to seven territories each.

On March 9, 1997, a fire started by an adjacent landowner burned a 32-hectare portion of the Escalante Wildlife Area near Delta, Colorado. That location comprised one of the largest known breeding sites for southwestern willow flycatchers in Colorado with approximately seven pairs occupying the site in 1996.

Utah

Specimen data reveal that southwestern willow flycatcher historically occurred in southern Utah along the Colorado River, San Juan River, Kanab Creek, Virgin River, and Santa Clara River (Unitt 1987). Their northern boundary in south-central Utah remains unclear due to a lack of specimen data from that region. The southwestern willow flycatcher no longer occurs along the Colorado River in Glen Canyon where Lake Powell inundated historically-occupied habitat, nor in unflooded portions of Glen Canyon near Lee's Ferry where southwestern willow flycatchers were documented nesting in 1938. Similarly, recent surveys on the Virgin River and tributaries and Kanab Creek have failed to document their presence (McDonald *et al.* 1995). Single, territorial males and possibly a pair of southwestern willow flycatchers were documented at 2 locations on the San Juan River (San Juan Co.) in 1995, but breeding was not confirmed (Sogge 1995b). The population totals for Utah are summarized in Table 2.

Nevada

Unitt (1987) documented 3 locations in Clark County from which southwestern willow flycatchers had been collected, but not found after 1970. Current survey efforts have documented a single location with 2 unmated males on the Virgin River in Clark County (Tomlinson *in litt.*; Table 2).

Rangewide, the current known population of southwestern willow flycatchers stands at approximately 454 territories (Table 2). These results indicate a critical population status; more than 75% of the locations where flycatchers have been found are comprised of 5 or fewer territorial birds and up to 20% of the locations are comprised of single, unmated individuals. The distribution of breeding groups is highly fragmented, with groups often separated by considerable distances (e.g., approximately 88 kilometer straight-line distance between breeding

flycatchers at Roosevelt Lake, Gila Co., Arizona, and the next closest breeding groups known on either the San Pedro River (Pinal Co.) or Verde River (Yavapai Co.)). Additional survey effort, particularly in southern California, may discover additional small breeding groups. However, rangewide survey efforts have yielded positive results in less than 10% of surveyed locations. Moreover, survey results reveal a consistent pattern rangewide: the southwestern willow flycatcher population as a whole is comprised of extremely small, widely-separated breeding groups or unmated individuals.

The data presented in Table 2 represents a composite of surveys conducted since 1992. Locations that had southwestern willow flycatchers for only one year were tabulated as if the location is still extant. Given that extirpation has been documented at several locations during the survey period, this method of analyses introduces a bias that may overestimate the number of breeding groups and overall population size. In addition, females have been documented singing as frequently as males. Because the established survey method relies on singing birds as the entity defining a territory (Tibbitts *et al.* 1994), double-counting may be another source of sampling error that biases population estimates upward. The figure of 454 southwestern willow flycatcher territories is an approximation based on considerable survey effort, both extensive and intensive. Given sampling errors that may bias population estimates positively or negatively (e.g., incomplete survey effort, double-counting males/females, composite tabulation methodology), natural population fluctuation, and random events, it is likely that the total population of southwestern willow flycatchers is fluctuating at between 300 and 500 territories with a substantial proportion of individuals remaining unmated. If all extant sites were fully protected, at such low population levels random demographic, environmental, and genetic events could lead to extirpation of breeding groups and eventually render this species extinct. The high proportion of unmated individuals documented during recent survey efforts suggests the southwestern willow flycatcher may already be subject to a combination of these factors (e.g., uneven sex ratios, low probability of finding mates in a highly fragmented landscape).

Southwestern willow flycatcher reproductive success

Intensive nest monitoring efforts in California, Arizona, and New Mexico have revealed that: (1) sites with both relatively large and small numbers of pairs have experienced extremely high rates of brood parasitism; (2) high levels of cowbird parasitism in combination with nest loss due to predation have resulted in low reproductive success and, in some cases, population declines; (3) at some sites, levels of cowbird parasitism remain high across years, while at others parasitism varies temporally with cowbirds absent in some years; (4) the probability of a southwestern willow flycatcher successfully fledging its own young from a nest that has been parasitized by cowbirds is low (i.e., <5%); (5) cowbird parasitism and/or nest loss due to predation often result in reduced fecundity in subsequent nesting attempts, delayed fledging, and reduced survivorship of late-fledged young, and; (6) nest loss due to predation appears more constant from year to year and across sites, generally in the range of 30 to 50%.

On the South Fork Kern River (Kern Co., CA), Whitfield (1993) documented a precipitous decline in the southwestern willow flycatcher breeding population from 1989 to 1993 (44 to 27

pairs). During that same period cowbird parasitism rates between 50 and 80 percent were also documented (Whitfield 1993; Table 4). A cowbird trapping program initiated in 1993 reduced cowbird parasitism rates to $< 20\%$. Southwestern willow flycatcher population numbers appear to have stabilized at 32 to 34 pairs in 1993, 1994, and 1995 (Whitfield 1994, Whitfield and Strong 1995). Predation rates have remained relatively constant in the range of 33 to 47% (Table 4). Southwestern willow flycatcher nest success increased from 26% prior to cowbird trapping to 48% after trapping was implemented (Whitfield and Strong 1995). In addition, the number of young fledged also increased from 1.01 young/pair to 1.73 young/pair during the same period.

Whitfield and Strong (1995) found that, besides lowering nest success, fecundity, and the number of young produced, cowbird parasitism may also lower survivorship of southwestern willow flycatcher young fledged late in the season. Southwestern willow flycatchers that abandon parasitized nests or renest after fledging cowbirds lay fewer eggs in subsequent clutches and, if successful, fledge young late in the season. Whitfield and Strong determined that cowbird parasitism delayed successful southwestern willow flycatcher nesting by at least 13 days and this delay resulted in significantly different return rates of juveniles. Only 6.4% of southwestern willow flycatcher young that came from late nests were recaptured in subsequent years, whereas 21.9% of young that came from early nests were recaptured. If these recapture rates mirror actual survivorship, then even though some parasitized southwestern willow flycatchers eventually fledge their own young, nest loss due to parasitism or depredation may have the more insidious effect of reducing overall juvenile survivorship. Despite the cowbird trapping program and increased reproductive success, Whitfield has not observed a population increase at her study area. Whitfield and Strong (1995) speculate that other factors in addition to cowbird parasitism, such as habitat loss and pesticide use on wintering grounds and/or stochastic events such as storms resulting in mortality, may be keeping population numbers low.

The number of unmated, territorial, and paired southwestern willow flycatchers detected on the Colorado River in the Grand Canyon has remained low since monitoring began in 1982. Brown (1994) reported that at least 50% of the southwestern willow flycatcher nests monitored in the Grand Canyon between 1982 and 1987 were parasitized by brown-headed cowbirds. Brown (1994) did not report data on productivity. Given that the probability of successfully fledging a single chick is low when a nest is parasitized and the high proportion of nests parasitized during Brown's study, it is likely that southwestern willow flycatcher productivity during that period was also low. In 1992, when comprehensive nest monitoring was initiated, two pairs were present, with only one establishing a nest. That nest successfully fledged three chicks (Sogge and Tibbitts 1992).

In 1993, one breeding pair, one male with two females, and six unpaired males were detected. Three nests were found, all of which were parasitized by brown-headed cowbirds (Table 4). No southwestern willow flycatchers were successfully reared in Grand Canyon in 1993 (Sogge *et al.* 1993). Four pairs and one unpaired male occupied Grand Canyon in 1994. Nine nests were attempted, at least four of which were parasitized by cowbirds. All nesting attempts eventually failed due to predation or abandonment (Sogge and Tibbitts 1994). In 1995, one breeding pair

and three unpaired males were detected (Sogge *et al.* 1995). One nest was found with a single cowbird egg on May 23. On June 4, three southwestern willow flycatcher eggs were present, but the cowbird egg was missing. That nest successfully fledged one chick. In summary, since 1992, 10 known pairs of southwestern willow flycatchers have made 14 nesting attempts in the Grand Canyon, 2 of which successfully fledged a total of 4 chicks. This low rate of reproduction indicates that, even with the protections provided annually by the National Park Service (i.e., camping and other activities are prohibited at southwestern willow flycatcher breeding sites), this area is a population sink (Pulliam 1988) where reproduction is not adequate to replace adults and population persistence requires emigration from other breeding areas.

On the Verde River in Yavapai Co., Arizona, Ohmart (pers. comm.) discovered four pairs of southwestern willow flycatchers in 1992 at Clarkdale. The breeding status and reproductive success of those birds was not determined. In 1993, two pairs were present and one nest was documented. The nest contained a single cowbird nestling and eventually failed (Muiznieks *et al.* 1994; Table 4). In 1994, two pairs and one unpaired male were present. Two nests were found, one of which successfully fledged two chicks, the other fledged a single cowbird (Sferra *et al.* 1995). Data from a more limited monitoring effort in 1995 indicate that two unpaired males occupied the Clarkdale site (Sogge 1995a). Surveys during the 1996 breeding season failed to detect any southwestern willow flycatchers at the Clarkdale site. However, one nesting pair was discovered at Tavaschi Marsh approximately 2.4 km east of the Clarkdale site. Thus, although since its discovery the Clarkdale site has had several pairs, cowbird parasitism and nest loss due to depredation resulted in poor reproductive success and may have been responsible for abandonment or extirpation at this site.

Elsewhere in Arizona, population loss or undetected dispersal of breeding groups has been documented since 1993. For example, surveys in 1993 estimated five territorial males at Dudleyville Crossing on the San Pedro River (Pinal Co.). However, surveys in 1994 and 1995 failed to detect any southwestern willow flycatchers at that location (Muiznieks *et al.* 1994, Sferra *et al.* 1995, Spencer *et al.* 1996). Southwestern willow flycatchers detected in 1993 at Soza Wash on the San Pedro River were not detected in follow-up surveys in 1995, and an individual observed at Ister Flat on the Verde River was not detected in follow-up surveys during 1994. It is not known whether these events represent mortality of southwestern willow flycatchers, changes in habitat quality, or simply a vagile tendency inherent to this species. At other locations on the San Pedro River in Pinal Co., such as Cook's Lake and PZ Ranch, southwestern willow flycatcher breeding group size has remained stable. However, in 1996 a catastrophic fire destroyed much of the breeding habitat at PZ Ranch resulting in nest loss, abandonment of that site and, perhaps, mortality of adults (Paxton *et al.* 1996).

On the Little Colorado River in Apache County, Arizona, a cowbird parasitism rate of 22% was documented in 1994 (Table 4). In 1995 the parasitism rate was zero. Nest loss due to depredation, however, remained relatively constant (Table 4). On the Rio Grande in Socorro Co., New Mexico, parasitism rates increased from 20% in 1994 to 66% in 1995. In 1996, water was diverted above that breeding location and no southwestern willow flycatchers were present (D. Leal, pers. comm.). It is not known whether those birds dispersed elsewhere or if

that breeding group was extirpated. Finally, on the Gila River in Grant Co., NM, Skaggs (1995) monitored 46 nests from a breeding group of approximately 135 pairs. From a subset of 25 nests whose contents were checked directly or inferred through observation, Skaggs estimated a cowbird parasitism rate of between 16 and 27% for 1995 (Table 4).

The data presented above and in Table 4 demonstrate that cowbird parasitism and nest depredation are affecting southwestern willow flycatchers throughout their range. Cowbirds have been documented at more than 90% of sites surveyed (Sogge and Tibbitts 1992, Sogge *et al.* 1993, Camp Pendleton 1994, Muiznieks *et al.* 1994, Sogge and Tibbitts 1994, T. Ireland 1994 *in litt.*, Whitfield 1994, C. Tomlinson 1995 *in litt.*, Griffith and Griffith 1995, Holmgren and Collins 1995, Kus 1995, Maynard 1995, McDonald *et al.* 1995, Sferra *et al.* 1995, Sogge 1995a, Sogge 1995b, Sogge *et al.* 1995, Cooper 1996, San Diego Natural History Museum 1995, Stransky 1995, Whitfield and Strong 1995, Griffith and Griffith 1996 *in litt.*, Skaggs 1995, Spencer *et al.* 1996). Thus, the potential for cowbirds to be a persistent and widespread threat remains high. Cowbird trapping has been demonstrated to be an effective management strategy for increasing reproductive success for the southwestern willow flycatcher as well as for other endangered Passerines (e.g., least Bell's vireo [*Vireo bellii pusillus*]-capped vireo [*V. atricapillus*], golden-cheeked warbler [*Dendroica chrysoparia*]). It may also benefit juvenile survivorship by increasing the probability that parents fledge birds early in the season. Expansion of cowbird management programs has the potential to not only increase reproductive output and juvenile survivorship at source populations, but also to potentially convert small, sink populations into breeding groups that contribute to population growth and expansion.

Nest loss due to predation is common among small Passerines. The rates documented for southwestern willow flycatchers are also typical for small Passerines (i.e., rates < 50%). However, even at these "typical" levels nest loss due to predation is a significant factor contributing to low reproductive success. Nest predation presents a difficult management challenge because of the variety of taxa involved and the difficulty in developing an effective management plan for more than one taxon. Until specific predators on southwestern willow flycatcher nests are identified, measures to reduce potential predator populations should focus on reducing human activities that attract predators, such as camping, picnicking, etc. where pets are loose and refuse is concentrated.

The rangewide reduction in the southwestern willow flycatcher population reflects the widespread, continual loss and fragmentation of riparian habitats into smaller and more isolated remnants. Declines in willow flycatchers, however, have not been restricted to the subspecies *E.t. extimus*. Breeding Bird Survey data for 1965 through 1979 combined the willow and alder flycatchers into the "Traill's flycatcher" because of taxonomic uncertainty during the 15-year reporting period. These data showed fairly stable numbers in central and eastern North America, but sharp declines in the West, the region in which the alder flycatcher is absent and where *E.t. brewsteri*, *E.t. extimus*, and *E.t. adastus* occur (Robbins *et al.* 1986).

Huachuca Water Umbel

STATUS OF THE SPECIES (rangewide)

The Huachuca water umbel was listed as an endangered species on January 6, 1997. Critical habitat was not designated. The umbel is an herbaceous, semiaquatic perennial plant with slender, erect leaves that grow from creeping rhizomes. The leaves are cylindrical, hollow with no pith, and have septa (thin partitions) at regular intervals. The yellow/green or bright green leaves are generally 0.04-0.12 inches in diameter and often one to two inches tall, but can reach up to eight inches tall under favorable conditions. Three to 10 very small flowers are borne on an umbel that is always shorter than the leaves. The fruits are globose, 0.06-0.08 inches in diameter, and usually slightly longer than wide (Affolter 1985). The species reproduces sexually through flowering and asexually from rhizomes, the latter probably being the primary reproductive mode. An additional dispersal opportunity occurs as a result of the dislodging of clumps of plants which then may re-root in a different site along aquatic systems.

Huachuca water umbel was first described by A.W. Hill based on the type specimen collected near Tucson in 1881 (Hill 1926). Hill applied the name *Lilaeopsis recurva* to the specimen, and the name prevailed until Affolter (1985) revised the genus. Affolter applied the name *L. schaffneriana* ssp. *recurva* to plants found east of the continental divide.

Huachuca water umbel has been documented from 23 sites in Santa Cruz, Cochise, and Pima counties, Arizona, and in adjacent Sonora, Mexico, west of the continental divide (Saucedo 1990, Warren et al. 1989, Warren et al. 1991, Warren and Reichenbacher 1991, Service files). The plant has been extirpated from six of the 23 sites. The 17 extant sites occur in four major watersheds - San Pedro River, Santa Cruz River, Rio Yaqui, and Rio Sonora. All sites are between 3,500 to 6,500 ft elevation.

Huachuca water umbel has an opportunistic strategy that ensures its survival in healthy riverine systems, cienegas, and springs. In upper watersheds that generally do not experience scouring floods, the umbel occurs in microsites where interspecific plant competition is low. At these sites, the umbel occurs on wetted soils interspersed with other plants at low density, along the periphery of the wetted channel, or in small openings in the understory. The upper Santa Cruz River and associated springs in the San Rafael Valley, where a population of Huachuca water umbel occurs, is an example of a site that meets these conditions. The types of microsites required by the umbel were generally lost from the main stems of the San Pedro and Santa Cruz rivers when channel entrenchment occurred in the late 1800's. Habitat on the upper San Pedro River is recovering, and Huachuca water umbel has recently been found along short reaches of the main channel.

The umbel was found in Empire Gulch in the Empire Cienega allotment in 1996 by Peter Warren. Only a very small patch of Huachuca water umbel was found. During a second visit to the site, Dr. Warren was unable to locate the umbel (P. Warren, pers. comm. 1997). However, potential habitat is widespread along Cienega Creek and Dr. Warren believes (pers.

comm. 1997) habitat conditions are improving for the umbel with recent improvements in grazing management. Cattle lightly graze the area where the water umbel occurs in Empire Gulch (P. Warren, pers. comm. 1997).

In stream and river habitats, Huachuca water umbel can occur in backwaters, side channels, and nearby springs. After a flood, it can rapidly expand its population and occupy disturbed habitat until interspecific competition exceeds its tolerance. This response was recorded at Sonoita Creek in August 1988, when a scouring flood removed about 95 percent of the Huachuca water umbel population (Gori et al. 1990). One year later, the umbel had recolonized the stream and was again codominant with watercress, *Rorippa nasturtium-aquaticum* (Warren et al. 1991). The expansion and contraction of Huachuca water umbel populations appears to depend on the presence of "refugia" where the species can escape the effects of scouring floods, a watershed that has an unaltered hydrograph, and a healthy riparian community that stabilizes the channel.

Density of umbel plants and size of populations fluctuate in response to both flood cycles and site characteristics. Some sites, such as Black Draw, have a few sparsely-distributed clones, possibly due to the dense shade of the even-aged overstory of trees, dense nonnative herbaceous layer beneath the canopy, and deeply entrenched channel. The Sonoita Creek population occupies 14.5 percent of a 5,385 ft² patch of habitat (Gori et al. 1990). Some populations are as small as 11-22 ft². The Scotia Canyon population, by contrast, has dense mats of leaves. Scotia Canyon contains one of the larger Huachuca water umbel populations, occupying about 57 percent of the 1,450 m (4,756 ft) perennial reach (Gori et al. 1990; Jim Abbott, Coronado National Forest, Tucson, AZ, in litt. 1994).

While the extent of occupied habitat can be estimated, the number of individuals in each population is difficult to determine because of the intermeshing nature of the creeping rhizomes and the predominantly asexual mode of reproduction. A 'population' of Huachuca water umbel may be composed of one or many genetically distinct individuals.

Overgrazing, mining, hay harvesting, timber harvest, fire suppression, and other activities in the nineteenth century led to widespread erosion and channel entrenchment in southeastern Arizona streams and cienegas when above-average precipitation and flooding occurred in the late 1800's (Bahre 1991, Bryan 1925, Dobyns 1981, Hastings and Turner 1980, Hendrickson and Minckley 1984, Martin 1975, Sheridan 1986, Webb and Betancourt 1992). These events contributed to long-term or permanent degradation and loss of cienega and riparian habitat throughout southern Arizona and northern Mexico. Much habitat of the Huachuca water umbel and other cienega-dependent species was presumably lost at that time.

Wetland degradation and loss continues today. Human activities such as groundwater overdrafts, surface water diversions, impoundments, channelization, improper livestock grazing, chaining, agriculture, mining, sand and gravel operations, road building, nonnative species introductions, urbanization, wood cutting, and recreation all contribute to riparian and cienega habitat loss and degradation in southern Arizona. The local and regional effects of these activities are expected to increase with the increasing human population.

Dredging extirpated the Huachuca water umbel from House Pond, near the extant population in Black Draw (Warren *et al.* 1991). The umbel population at Zinn Pond in St. David near the San Pedro River was probably lost when the pond was dredged and deepened. This population was last documented in 1953 (Warren *et al.* 1991).

Livestock grazing can affect the umbel through trampling and changes in stream hydrology and loss of stream bank stability. However, existence of the umbel appears to be compatible with well-managed livestock grazing (Service 1997). In overgrazed areas, stream headcutting can threaten cienegas where the umbel occurs. Such headcutting occurs at Black Draw just south of the international boundary and at Los Fresnos, in the San Rafael Valley, Sonora. Groundwater pumping has eliminated habitat in the Santa Cruz River north of Tubac, and threatens habitat in the San Pedro River. Severe recreational impacts in unmanaged areas can compact soils, destabilize stream banks, and decrease riparian plant density, including densities of the Huachuca water umbel. Populations in Bear Canyon in the Huachuca Mountains have been impacted by trampling and off-highway vehicles.

A suite of nonnative plant species has invaded wetland habitats occupied by the Huachuca water umbel. In some cases their effect on the umbel is unclear. However, in certain microsites, the nonnative Bermuda grass, *Cynodon dactylon*, may directly compete with the umbel. Bermuda grass forms a thick sod in which many native plants are unable to establish. Watercress is another nonnative plant now abundant along perennial streams in Arizona. It is successful in disturbed areas and can form dense monocultures that can outcompete Huachuca water umbel populations.

Limited numbers of populations and the small size of populations makes the Huachuca water umbel vulnerable to extinction as a result of stochastic events that are often exacerbated by habitat disturbance. For instance, the restriction of this taxon to a relatively small area in southeastern Arizona and adjacent Sonora increases the chance that a single environmental catastrophe, such as a severe tropical storm or drought, could eliminate populations or cause extinction. Populations are in most cases isolated, as well, which makes the chance of natural recolonization after extirpation less likely. Small populations are also subject to demographic and genetic stochasticity, which increases the probability of population extirpation (Shafer 1990, Wilcox and Murphy 1985).

Environmental Baseline

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

The development of limited and sparsely-distributed water resources in the Southwest has resulted in large-scale changes to aquatic and riparian systems. Those changes include losses of perennial aquatic ecosystems due to dams, diversions, and groundwater pumping; conversion of alluvial-influenced riparian areas to lacustrine-influenced reservoirs; loss and fragmentation of riparian and aquatic habitats due to residential, commercial, and agricultural development, overgrazing in riparian areas and in watersheds; modifications to stream systems from bank stabilization efforts and channelization; and invasion of remaining riparian areas by exotic species such as saltcedar. These activities and impacts are common among major stream systems in the Southwest.

Status of the Species Within the Action Area

Southwestern willow flycatcher

The San Pedro River is one of the last bastions of the southwestern willow flycatcher, and the upward trend in riparian vegetation along the river indicates that suitable habitat will continue to increase. The BLM acted laudably in removing livestock from the NCA, and riparian areas are recovering from years of degradation. In recent years, most flycatcher territories and breeding records have been along the lower San Pedro, in the vicinity of the river's confluence with the Gila River. Occasional solitary individuals have been observed near the proposed beaver reintroduction, but breeding has not been observed since 1977 (amended BE). However, during the summer of 1997 a pair of flycatchers nested in the reintroduction area near Hwy. 90, and another bird established a territory just north of Hwy. 90. The 1997 nesting record bodes well for future occupancy of suitable habitat in the proposed beaver reintroduction area. As yet, many areas of the San Pedro River within the proposed reintroduction site are still too deeply incised to support riparian vegetation patch sizes large enough to support breeding flycatchers. Where dense willows are found, they are usually stringers along the river. Only a few patches are currently large enough to support flycatchers, but the improving condition of riparian vegetation should eventually result in larger areas of suitable habitat.

The action area comprises only a small area of the subspecies' range. However, critical habitat for the southwestern willow flycatcher has been designated, including the upper San Pedro River from the Hereford bridge downstream to Benson (62 FR 39129-39147), and thus the Service must consider adverse modification of habitat as part of possible effects of the action. Additionally, the proposed reintroduction area is likely to be dynamic in its boundaries, due to dispersal by adult and juvenile beaver, such that the action area has the potential to expand to include a larger portion of southwestern willow flycatcher critical habitat. Thus the distribution of affected and unaffected habitat within and without the action area cannot be precisely determined, but potentially may include all areas of the San Pedro River with surface flow and possibly other drainages/bodies of water which could receive dispersing beaver.

The constituent elements of critical habitat for the southwestern willow flycatcher are provided or will be provided by dense thickets of riparian shrubs and trees (native and exotic species). This vegetation, by definition, occurs near rivers, streams, open water, cienegas, marshy seeps,

or saturated soil. Constituent elements also include the riparian ecosystem within the 100-year floodplain, including areas where dense riparian vegetation is not present, but may become established in the future. The final critical habitat rule for the southwestern willow flycatcher defines those activities which may adversely modify critical habitat, including removing, thinning, or destroying riparian vegetation. Activities which remove, thin, or destroy riparian vegetation, by mechanical, chemical, or biological means reduce constituent elements for southwestern willow flycatcher sheltering, feeding, breeding, and migrating. Critical habitat may also be adversely modified by destruction/alteration of the species' habitat by discharge of fill material, draining, ditching, tilling, pond construction, and stream channelization.

Refer to the discussion below pertaining to the Huachuca water umbel for a discussion of federal, state, and private actions which may affect groundwater levels, maintenance of surface flow, and vegetative communities along the San Pedro River.

Huachuca water umbel

Nine known Huachuca water umbel populations occur in the San Pedro River watershed in Arizona and Sonora on sites owned or managed by private landowners, Fort Huachuca Military Reservation, the Coronado National Forest, and the BLM Tucson Field Office. Two extirpated populations in the upper San Pedro watershed occurred at Zinn Pond in St. David and the San Pedro River near St. David. Cienega-like habitats were probably common along the San Pedro River prior to 1900 (Hendrickson and Minckley 1984, Jackson *et al.* 1987). These habitats are beginning to recover.

The Huachuca water umbel was located on the San Pedro River RNCA in 1994. Mark Fredlake (BLM) and Dave Gori (The Nature Conservancy, Tucson, AZ) located 43 patches of Huachuca water umbel during 1995 and 1996. These patches occur in five disjunct areas, including approximately two miles downstream of Fairbank, near Brunchow Hill downstream of Charleston, immediately north and south of Highway 90, approximately 2.5 miles downstream of Highway 90, and approximately one mile north of Hereford. The umbel is sensitive to flooding and populations may disappear while others become established during and after severe flood events. Two patches of Huachuca water umbel on the San Pedro River were lost during a winter flood in 1994 and had still not recolonized that area as of May 1995, demonstrating the dynamic and often precarious nature of occurrences within a riparian system (Al Anderson, Grey Hawk Ranch, *in litt.* 1995). However, after high flows in 1996, no apparent loss or reduction in approximately 12 Huachuca water umbel patches was noted by Dr. Peter Warren (The Nature Conservancy, Tucson, pers. comm. 1997). The entire San Pedro RNCA is considered potential habitat for the Huachuca water umbel. It is the largest contiguous potential habitat of the umbel, and as such is considered the most important site for recovery.

Few human impacts to umbel habitat in the San Pedro River have occurred since establishment of the RNCA; however, recreation and associated impacts are becoming increasingly evident. The greatest threat to umbel habitat on the San Pedro River is continued groundwater pumping in excess of recharge in the Sierra Vista subwatershed. Recreation is occurring in some areas,

and may be adversely affecting the umbel through trampling and bank erosion in some areas, particularly at the Highway 90 locality.

Two BLM allotments include grazing of cattle in riparian areas of the San Pedro River RNCA, including the Babocomari allotment and the Brunchow Hill allotment. Removal of grazing from BLM-administered lands within the riparian areas is ongoing. Trespass cattle have also been a problem within the RNCA both inside and outside of allotments, particularly near the confluence of the Babocomari and San Pedro rivers, and on the San Pedro River at and just below Highway 90, at Fairbank, and in the vicinity of the St. David Diversion. The BLM has been recently removing trespass cattle from this area. To date, 79 cattle have been removed (Mark Fredlake, BLM, pers. comm. 1997).

Effects of livestock grazing in riparian systems, and specifically, on the Huachuca water umbel and its habitat, are many and complex. Cattle are attracted to water and forage in riparian areas and, as a result, spend a disproportionate time in riparian areas, if not controlled. Grazing can alter plant species composition and growth form, density of stands, vigor, and seed production (Ryder 1980). Heavy grazing in riparian areas typically results in reduced understory and bankline vegetation, bushy growth forms caused by browsing of terminal buds, and in some cases, replacement of native species by nonnatives such as saltcedar, *Tamarix chinensis* (Krueper 1995). Reduced vegetation cover and trampling of banks results in increased soil erosion and higher peak flows (Lusby 1979). Even minor trampling of soils can result in significant damage to floral and soil structure components (Kuss and Hall 1991). Other effects include decreased water quality (Szaro 1989), soil compaction (Fleischner 1994), and decreased nutrient retention (Sewards and Valet 1995).

Grazing in the watershed of a riparian system can also affect riparian functions. Disturbance of soils, cryptobiotic crusts, and removal of vegetation in the watershed by grazing combine to increase surface runoff and sediment transport and decrease infiltration of precipitation (Belsky and Blumenthal 1997, Busby and Gifford 1981, DeBano and Schmidt 1989, Belnap 1992, Gifford and Hawkins 1979, Blackburn 1984). Effects are cumulative and interactive. Loss of vegetation cover and trampling of soils promote deterioration of soil structure which in turn accelerates vegetation loss. These changes in the watershed tend to increase peak flows and reduce low flows (DeBano and Schmidt 1989), making the stream more "flashy". The Huachuca water umbel is sensitive to changes in water level and may be eliminated during floods or drought. Thus, changes in the watershed attributable to grazing can reduce habitat quality for the umbel. Adverse effects to watershed function are especially well-documented for heavy grazing regimes; however, less information is available for watersheds grazed moderately or lightly. In regard to comparisons of watershed condition under light, moderate, or ungrazed regimes, some studies show no difference in soil loss, infiltration capacity, or bulk density among (Blackburn 1984), while others show measurable differences in watershed function (Gifford and Hawkins 1978).

Assessing the effects of grazing in the allotments east of the San Pedro River on watershed function is problematic because no assessment of watershed conditions have been made. The

only information we have available to us is range condition, which is a measure of the percentage of the potential species composition of the natural vegetation represented by the current plant community. Watershed condition, as we refer to it here, is a measure of current versus potential condition of soils and vegetation communities in regard to water infiltration rates, erosion rates, and runoff rates. A watershed in good condition will have low rates of erosion and runoff and high rates of infiltration, given the potential of the site in terms of existing soils and potential vegetation communities. As discussed above, grazing disturbs soils and alters vegetation communities in a way that often degrades watershed condition. Range condition is related to grazing intensity, and grazing intensity is related to watershed condition; thus range condition and watershed condition are likely related, as well. However, the relationship between range condition and watershed condition is complex; in southeastern Arizona the two are probably often, but not necessarily, correlated. This is particularly true where native perennial grasses are, or should be, abundant. Exceptions may be areas in which Lehmann lovegrass is common. Areas dominated by Lehman lovegrass may exhibit good watershed condition but poor range condition. Assuming range condition is largely correlated with watershed condition, portions of the allotments in fair or poor condition are expected to exhibit lower water infiltration and retention rates, greater sediment transport, and erosion of surface soils and headcutting, in comparison to rangelands in good or excellent condition, given similar soils, terrain, and potential vegetation communities. Of the BLM allotments in the watershed, the percentage of lands in the excellent (potential natural community), good (late seral), fair (mid seral), and poor condition classes (early seral) are one, 12, 42, and 45, respectively. Eighty-seven percent are in either fair or poor condition; forty-five percent of the BLM lands in the allotments are in poor condition. Ranges in fair and poor condition are those lands where the plant community is 49 to 25 and 24 to 0% of a site's potential, respectively. Although these figures do not conclusively support degraded watershed condition, they are suggestive of degraded watersheds, with associated adverse effects to the Huachuca water umbel and its habitat.

As discussed above, one of the effects of livestock grazing on watersheds is reduced water infiltration rates as a result of reduced vegetation cover and compaction of soils (Lull 1959). In a forested area of Colorado, a five year exclusion of cattle resulted in a 60% increase in water infiltration rates, whereas infiltration rates on nearby grazed areas declined (Smith 1967). In the Davis Mountains-Big Bend area of Texas, Leithead (1959) suggested that ranges in good condition absorb moisture five to six times faster than ranges in poor condition. On Walnut Gulch in the San Pedro River watershed, Arizona, Tromble et al. (1974) found that infiltration rates were 33% higher in ungrazed areas as compared to heavily grazed rangelands.

Based on studies in many vegetation communities under a variety of grazing strategies, Gifford and Hawkins (1978) found that the effect of grazing on infiltration rates can be roughly estimated as follows: Moderate/light grazing reduces infiltration rates to about 0.75 of the ungrazed condition, and heavy grazing reduces infiltration to about 0.67 of the moderate/light condition, or 0.5 of the ungrazed condition.

Gifford and Hawkins' (1978) review indicates that grazing significantly affects infiltration under a variety of conditions and vegetation communities. As discussed earlier, the major threat to the water umbel on the San Pedro River is the likelihood that groundwater pumping in excess of recharge will in time lower the groundwater elevation and result in dewatering of the San Pedro River. Infiltration is necessary for recharge of the aquifer. Changes in infiltration rates over the watershed are expected to be correlated with changes in recharge rates. An estimated 1.2 million acre-feet of precipitation falls on the Sierra Vista subwatershed. Of this only 13,860 acre-feet (1%) is recharged into the groundwater aquifer (ASL 1994). Conceptually, very small increases in infiltration rates could yield relatively large increases in groundwater recharge. For instance if infiltration into the groundwater aquifer increased by one percent throughout the Sierra Vista subwatershed, recharge would exceed all current groundwater uses and losses, and in time and at current pumping rates, the cones of depression in the aquifer would diminish. Grazing on the allotments in the watershed is likely reducing infiltration rates. Whether such reduction is causing a reduction in recharge is unknown. Most aquifer recharge occurs in and along stream courses that drain the mountains on the edges of the watershed (ASL 1994) (Huachuca, Mule, Dagoon, and Whetstone mountains), rather than on the bajada where the Bureau allotments occur. However, some level of recharge probably occurs in the Bureau allotments. Extrapolating from Gifford and Hawkins' analysis, this recharge is likely reduced as a result of grazing activities. The level of reduction is probably small in relation to the recharge throughout the watershed. Nevertheless, reduced recharge resulting from grazing may be contributing to the current deficit between groundwater recharge and use.

Reduced infiltration rates caused by grazing also results in increased runoff. In the Black Hills National Forest livestock grazing resulted in a 60% increase in summer storm runoff (Orr 1975). Runoff in turn promotes soil erosion. Smith (1967) found three to 10 times more sediment loss in grazed pastures as compared to ungrazed pastures. In another study, following elimination of livestock from the watershed, vegetation cover increased 150%, the proportion of annual summer runoff dropped 72%, and sediment loss dropped 50% (Forsling 1931). Based on these findings, rangelands in the 19 allotments in fair and poor condition are expected to contribute loads and runoff to the San Pedro River than if these lands were ungrazed. Elevated sediment loads caused by grazing could bury patches of water umbel and higher peak flows caused by increased runoff could scour out plants and cause downcutting and loss of wetland habitat.

Groundwater pumping in the Sierra Vista subwatershed has increased dramatically since the early 1960's (ASL 1994). Annual water use exceeds supplies by approximately 11,200 acre-feet and has resulted in cones of depression in the aquifer at areas with significant groundwater pumping. These areas include Sierra Vista and Fort Huachuca, Huachuca City, and the Hereford - Palominas (Water and Environmental Systems Technology, Inc. 1994). Although the relationships between groundwater pumping and river flow are complicated, continued unmitigated groundwater withdrawal threatens to reduce or eliminate baseflows in the San Pedro River (Arizona Department of Water Resources 1991, ASL 1995, Water and Environmental Systems Technology, Inc. 1994). A reduction in baseflow as a result of groundwater pumping in the Sierra Vista - Fort Huachuca area could occur within 25 years, but such effects could be reduced by water conservation, watershed management, effluent recharge, or other measures to

reduce water use or increase recharge (ASL 1995, Water and Environmental Systems Technology, Inc. 1994). The San Pedro River is the largest contiguous habitat of the Huachuca water umbel and is considered the most important recovery area for the taxon.

Effects of the action

The difficulties of predicting the behavior of a social and vagile species like beaver make it difficult to precisely determine the effects of beaver on the San Pedro River ecosystem. If beaver are successfully established along the San Pedro River, they may colonize surrounding waters on private and public land. They may also colonize the uppermost reaches of the San Pedro River in the Republic of Mexico.

The amendment to the original BE states that beaver complexes on the middle Gila River, at Bill Williams National Wildlife Refuge, and in Cajon Bonito (Sonora) have been reviewed to determine impacts to the native vegetation, in particular cottonwood and willow trees. In none of these areas was it observed that the cottonwood and willow trees were being negatively impacted. Behind each of the herbaceous dams (sedge and cattails were the primary building materials) thousands of willow and cottonwood seedlings were becoming established. In addition, it appeared in these areas that beaver were primarily eating herbaceous vegetation and there was little sign of felled trees of any size. If this is the case along the San Pedro River, then beaver may produce a net positive increase in the cottonwood/willow gallery forest.

Southwestern willow flycatcher

The duration of effects to the flycatcher is difficult to determine. It is likely that beaver will have a short-term adverse effect on critical habitat by removing some woody riparian vegetation. Resultant reductions in vegetation density in patches of suitable or occupied habitat could render the area unsuitable for nesting attempts and could allow penetration of parasitic cowbirds to existing flycatcher nests. However, it is predicted that localized increases in the water table which may result from establishment of beavers and concomitant dams will result in long-term establishment of riparian vegetation and eventual improvement in constituent elements of critical habitat. Direct effects to flycatchers such as felling of trees with occupied nests or flooding of nests above dams are expected to be of low frequency, but are likely to be permanent potential effects.

Beaver may migrate into watersheds adjoining the San Pedro, and thus the proposed reintroduction has the potential to affect multiple riparian areas, including the Babocomari River, the Santa Cruz River watershed, the Yaqui River, and/or the headwaters of the San Pedro River in Mexico. The only known extant population of beaver in these adjacent watersheds is found in the Yaqui River. In the other watersheds the chances of establishing a viable population through migration from the San Pedro River are apparently slight, and individual migrants will be monitored and controlled if necessary.

Huachuca water umbel

The effects of the proposed action on the Huachuca water umbel will primarily result from habitat changes brought about by beaver activity as the animals are not expected to consume the plant. The direct effects will likely occur in the form of displacement of some individuals through flooding, dislodging and re-establishing in the wetted soil perimeter, in shallow water along the edge of the inundation, or actually as part of a vegetation mat floating free within the ponded area. It is possible that some individual plants could be buried by sediment as a result of beaver activity. Light soil disturbance as beaver move along the wetted perimeter feeding on cattails and bulrushes could also result in the removal or crushing of some individual plants; however, the removal of competing plants and light disturbance would provide a positive opportunity for expansion for the Huachuca water umbel. Quantification of the impacts to individual plants is not possible because the result of the proposed action is actually a change in habitat condition and functioning. Cienega habitats were probably common along the San Pedro River prior to 1900 (Hendrickson and Minckley 1984, Jackson et al. 1987). Many of these habitats have now been destroyed or modified to the point where they no longer support cienega species such as the water umbel. Beaver activity resulting in positive changes to the habitat may help recreate areas with these cienega-like characteristics within the system again.

Indirect effects of the proposed action are dependent on the degree of habitat change resulting from beaver activity. An increase in ponded areas may also result in an increase in recreational activity at those sites. Increased recreational activity may result in trampling of water umbel patches, soil compaction of the wetted soil perimeter of the ponded area, and a general degradation of the wetland habitat. The successional development of marsh vegetation surrounding ponded areas may serve to deter some recreational activity over time, thus alleviating many of the associated impacts to the water umbel.

CUMULATIVE EFFECTS

Cumulative effects are those adverse effects of future non-Federal (State, local government, and private) actions that are reasonably certain to occur in the project area. Future Federal actions would be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed project. Effects of past Federal and private actions are considered in the Environmental Baseline.

Continued groundwater pumping by the City of Sierra Vista and adjoining residential areas may lower the aquifer around the San Pedro River. Reduced groundwater supplies and low recharge rates may eventually eliminate surface flow along the San Pedro River during at least part of the year in many areas. This could concentrate beaver in the few areas with perennial flow and increase the localized effects of beaver on riparian vegetation.

Trespass cattle from private ranching operations have been a problem at some sites in the San Pedro Riparian NCA in recent times. These cattle destabilized the river banks and browsed heavily on young cottonwoods and willows, resulting in soil erosion and decreased tree

recruitment in the riparian zone (S. Stefferud, pers. comm., 1997). Over 75 trespass cattle have been removed in the last year (M. Fredlake, pers. comm., 1997), and recent visits to the proposed reintroduction site indicated that adverse impacts of cattle grazing have been greatly reduced (R.N. Reed, pers. obs., 1997).

Thirteen of the 17 extant populations of the Huachuca water umbel occur entirely or in part on Federal lands. Thus, the effects of most actions on this plant will be subject to section 7 consultation and are not considered cumulative. The most serious cumulative effect of which the Service is aware is groundwater pumping in excess of recharge in the upper San Pedro River subwatershed. As discussed above, groundwater pumping threatens to lower groundwater elevations and reduce or eliminate surface flows in the San Pedro River (ASL 1994). The City of Sierra Vista has proposed effluent recharge and management of surface runoff, which may prevent dewatering of some reaches, but would also alter water quality and flow regimes, with unknown effects on the water umbel and its habitat. The Service is unaware of recharge efforts or proposals being undertaken by other communities in the area; however, many of these communities are rapidly expanding with many new master-planned subdivisions dependent on groundwater. To date, none of these activities are apparently subject to the consultation process.

CONCLUSION

After reviewing the current status of the southwestern willow flycatcher and the Huachuca water umbel, the environmental baseline for the action area, the effects of the proposed reintroduction of beaver into the upper San Pedro River and the cumulative effects, it is the Service's biological opinion that the reintroduction of beaver, as proposed, is not likely to jeopardize the continued existence of the southwestern willow flycatcher and the Huachuca water umbel, and is not likely to destroy or adversely modify designated critical habitat for the southwestern willow flycatcher.

INCIDENTAL TAKE STATEMENT

Sections 4(d) and 9 of ESA, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be implemented by the agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The BLM has a continuing duty to regulate the activity covered by this incidental take statement. If the BLM (1) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

AMOUNT OR EXTENT OF TAKE

The Service anticipates that incidental take of the southwestern willow flycatcher would most likely result in loss of productivity as a result of: (a) harm through loss of nests by felling of trees by beaver; (b) harm through flooding of nest sites upstream of beaver dams; or (c) harm or killing due to increased opportunities for cowbird parasitism or predation in areas where beaver have decreased vegetation density. Take of adult or juvenile birds as a direct effect of beaver introductions is not expected. The Service anticipates the following level of take:

- 1) One nest every 5 years due to felling of nest trees by beaver.
- 2) One nest every 5 years due to flooding, increased rates of predation or increased rates of nest parasitism in the vicinity of beaver dams.

If, during the course of the action, the amount or extent of the incidental take anticipated is exceeded, BLM must reinitiate consultation with the Service immediately to avoid violation of section 9. Operations must be stopped in the interim period between the initiation and completion of the new consultation if it is determined that the impact of the additional taking will cause an irreversible and adverse impact on the species, as required by 50 CFR 402.14(i). An explanation of the causes of the taking should be provided to the Service.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES (RPM)

The definition of an RPM is an action consistent with a proposed action's basic design, location, scope, duration, and timing. An RPM cannot cause more than a minor change to the project. Determining appropriate RPMs from this incidental take statement is complicated by the nature of the proposed action; specifics of beaver behavior and life history (including rates of tree felling, dispersal, fecundity, etc.) cannot be predicted with a high level of confidence, nor can the effects of these behaviors. Reducing the level of take from this action will require

management of beavers if take thresholds are met or exceeded, something which BLM cannot do directly but which must be done by cooperators in the project.

Southwestern willow flycatcher

The Service believes the following RPMs are necessary and appropriate to minimize take of southwestern willow flycatchers:

1. BLM will fund or conduct surveying and monitoring of southwestern willow flycatcher habitat in all areas deemed suitable habitat in the NCA where beavers exist or are likely to occur, and vegetation monitoring protocols will be expanded to quantify specific habitat requirements of the flycatcher.
2. BLM will include the Service in the scheduled evaluations of beaver effects at the one, two, and five-year intervals referred to in the project description.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of ESA, the BLM must comply with the following terms and conditions, which implement the reasonable and prudent measures described above for the southwestern willow flycatcher. These terms and conditions are nondiscretionary.

1. In order to implement RPM #1,
 - a. Monitoring will be done by BLM personnel with identical training and field tests to ensure inter-observer consistency in data collection. If BLM resources are inadequate to use trained staff, then volunteers may be used only if they: (a) are directly and rigorously supervised in the field by BLM personnel; (b) receive extensive training in the monitoring protocols; and (c) are available to conduct monitoring for multiple years, in order to reduce the total number of observers.
 - b. The southwestern willow flycatcher requires dense patches of riparian vegetation for successful nesting and reproduction. BLM will therefore add the following parameters to the vegetation sampling described in the BE and the amendment to the BE:
 - 1) Foliage density at 1, 2, and 3 meter heights along transects, using a foliage density board or similar device.
 - 2) Patch size of areas of dense riparian vegetation, including trends in patch area over time. Patch size of areas surrounding beaver dams should be compared to areas in the reintroduction site without beavers, using appropriate statistical techniques. This may be accomplished using aerial photographs combined with ground truthing.

- 3) Vegetation transects will be established in up to 10 vegetation patches which become occupied by southwestern willow flycatchers and where beavers occur or are expected to occur. Vegetation monitoring will take place after flycatchers migrate to wintering grounds and then again in the spring prior to the nesting season, so as not to disturb nesting birds.
- c. Surveys for southwestern willow flycatchers require a great deal of focused effort. Surveyors must be constantly alert and concentrate on detecting flycatcher responses (Sogge et al. 1997). Therefore, field work such as generalized bird surveys (i.e. point counts, transects, or any other portion of the Avian Monitoring program described in the amended BE), vegetation monitoring, or other distracting tasks will not be conducted during southwestern willow flycatcher surveys. Avoid bringing pets or additional, non-necessary people during southwestern willow flycatcher surveys. All surveys will be performed using the guidelines in Sogge *et al.* (1997).
- d. Monitoring of discovered nests is necessary to document take. Monitoring will follow that described in the draft southwestern willow flycatcher monitoring protocol (AGFD in prep), or another protocol agreed upon by the Service.

2. In order to implement RPM #2,

- a. At each Evaluation identified in the project description, BLM will have available by copy to the Service, summary reports of all monitoring, southwestern willow flycatcher survey reports, reports on southwestern willow flycatcher take, and report on how RPM #1 is being implemented.
- b. Evaluation at the fifth project year will include decisions on future monitoring and possible changes needed in this incidental take statement.

To the extent that this statement concludes that take of any threatened or endangered species of migratory bird will result from the agency action for which consultation is being made, the Service will not refer the incidental take of any such migratory bird for prosecution under the MBTA of 1918, as amended (16 U.S.C. §§ 703-712) or the Bald Eagle Protection Act of 1940, as amended (16 U.S.C. §§ 668-668d), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

Disposition of dead, injured, or sick individuals of a listed species:

If a dead, injured, or sick individual of a listed species is found at the project sites, initial notification must be made to Service Law Enforcement, Federal Building, Room 105, 26 North McDonald, Mesa, Arizona, 85201 (Telephone: 602/261-6443) within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the finding, a photograph of the animal, and any other pertinent information. The notification shall be sent to Law Enforcement with a copy to the Arizona Ecological Services

Field Office. Care must be taken in handling sick or injured animals to ensure effective treatment and care, and in handling dead specimens to preserve biological material with educational or research institutions holding appropriate State and Federal permits. If such institutions are not available, the information noted above shall be obtained and the carcass left in place. Arrangements regarding proper disposition of potential museum shall be made with the institution prior to implementation of the action. Injured animals should be transported to a qualified veterinarian by an authorized biologist. Should any treated animals survive, the Service shall be contacted regarding the final disposition of the animals.

CONSERVATION RECOMMENDATIONS

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendations provided here do not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the Huachuca water umbel. In furtherance of the purposes of the Act, we recommend implementing the following actions:

1. Develop and implement technical monitoring actions to allow assessment of recreational activity at the RNCA to determine and assess potential adverse effects to the Huachuca water umbel.
2. Develop and implement a site-specific conservation plan for the Huachuca water umbel in the RNCA including, but not limited to, gathering biological and ecological information relevant to the species' needs and providing information to enable management to support recovery of the species, information and education outreach activities, management actions to promote further re-establishment and recovery of the species in the San Pedro River, and to continue working with appropriate parties in resolving the water issues threatening the San Pedro River.

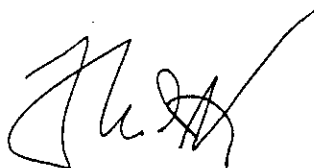
In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species, the Service requests notification of implementation of any conservation actions.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the action(s) outlined in the your request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent

not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If you have any questions or need further information, please contact Angie Brooks or Tom Gatz. Please refer to the consultation number, 2-21-97-F-097, in future correspondence concerning this project.



Thomas A. Gatz
Acting Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, NM (ES)
State Director, Bureau of Land Management, Phoenix, AZ
Field Office Manager, San Pedro Project Office, Sierra Vista, AZ

Director, Arizona Game and Fish Department, Phoenix, AZ
Director, Arizona Department of Agriculture, Phoenix, AZ

LITERATURE CITED

- Affolter, J.M. 1985. A monograph of the Genus Lilaeopsis (Umbelliferae). Systematic Botany Monographs Volume 6: 1-140.
- Aldrich, J. 1951. A review of the races of the Traill's flycatcher. *Wilson Bulletin* 63:192-197.
- American Ornithologists' Union. 1957. Checklist of North American birds. 5th ed. Lord Baltimore Press, Baltimore, Maryland. 691 pp.
- American Ornithologists' Union. 1983. Checklist of North American birds. 6th ed. Allen Press, Lawrence, Kansas. 877 pp.
- Arizona Department of Water Resources. 1991. Preliminary hydrologic survey report for the San Pedro River watershed. Volume 1: General Assessment. Phoenix, Arizona 548 pp.
- Arizona Game and Fish Department. 1996. Wildlife of special concern in Arizona (Draft). Nongame and Endangered Wildlife Program. Arizona Game and Fish Department, Phoenix, Arizona. 23 pp.
- ASL Hydrologic and Environmental Services. 1994. Sierra Vista sub-watershed hydrology primer. Report to the City of Sierra Vista, Bella Vista Water Company, Inc., and Pueblo Del Sol Water Company.
- ASL Hydrologic and Environmental Services. 1995. Report on the feasibility of groundwater recharge and sewage effluent reuse in the Sierra Vista sub-watershed. Report to the City of Sierra Vista and the U.S. Bureau of Reclamation, Boulder City, Nevada.
- Bahre, C.J. 1991. A legacy of change: Historic land use and vegetation in the Arizona borderlands. University of Arizona Press, Tucson. 231 pp.
- Behle, W.H. and H.G. Higgins. 1959. The birds of Glen Canyon. Pages 107-133, in A.M. Woodbury ed. Ecological Studies of Flora and Fauna in Glen Canyon. University of Utah.
- Belnap, J. 1992. Potential role of cryptobiotic soil crusts in semiarid rangelands. Paper presented at the Symposium on Ecology, Management, and Restoration of Intermountain Annual Rangelands, Boise, Idaho, May 18-1992.
- Belsky, A.J., and D.M. Blumenthal. 1997. Effects of livestock grazing on stand dynamics and soils in upland forests of the interior west. *Conservation Biology* 11 (2): 315-327.

- Bent, A.C. 1963. Life histories of North American flycatchers, larks, swallows and their allies. Dover Press, New York, New York. 555 pp. (Reprint of original 1942, U.S. National Museum Bulletin).
- Blackburn, W.H. 1984. Impacts of grazing intensity and specialized grazing systems on watershed characteristics and responses. Pages 927-983.
- Blake, E.R. 1953. Birds of Mexico. University of Chicago Press, Chicago, Illinois. 644 pp.
- Brittingham, M.C. and S.A. Temple. 1983. Have cowbirds caused forest songbirds to decline? *BioScience* 33:31-35.
- Brown, B.T. 1988a. Breeding Ecology of a Willow Flycatcher Population Along the Colorado River in Grand Canyon, Arizona. *Western Birds* 19:25-33.
- Brown, B.T. 1988b. Monitoring bird population densities along the Colorado River in Grand Canyon: 1987 breeding season. Final Report to the Glen Canyon Environmental Studies. Bureau of Reclamation, Salt Lake City, Utah. 26 pp.
- Brown, B.T. 1994. Rates of brood parasitism by brown-headed cowbirds on riparian passerines in Arizona. *Journal of Field Ornithology* 65:160-168.
- Browning, M.R. 1993. Comments on the taxonomy of *Empidonax traillii* (willow flycatcher). *Western Birds* 24:241-257.
- Bryan, K. 1925. Date of channel trenching (arroyo cutting) in the arid southwest. *Science* 62:338-344.
- Busby, F.E. and G.F. Gifford. 1981. Effects of livestock grazing on infiltration and erosion rates measured on chained and unchained pinyon-juniper sites in southeastern Utah. *Journal of Range Management* 34:400-405.
- California Department of Fish and Game. 1992. State and Federal endangered and threatened animals of California (Revised July 1992). California Department of Fish and Game, Natural Heritage Division, Sacramento, California. 13 pp.
- Camp Pendleton Marine Corps Base. 1994. Biological Assessment: Riparian and Estuarine Habitat.
- Cooper, C. 1996. Summary of 1995 surveys for willow flycatchers in New Mexico. Contract 96-516.51. New Mexico Department of Game and Fish. 27 pp.
- Corman, T.E., C.E. Paradzick, J.W. Rourke, S.J. Sferra, J.A. Spencer, and M.W. Sumner. 1996. Arizona Partners In Flight southwestern willow flycatcher survey 1993-1996

- summary report. Draft Technical Report. Nongame and Endangered Wildlife Program. Arizona Game and Fish Department, Phoenix, AZ. 97 pp.
- DeBano, L.F. and L.J. Schmidt. 1989. Interrelationship between watershed condition and riparian health. Pp. 45-52 in: Practical approaches to riparian resource management. U.S. Bureau of Land Management, Billings, MT.
- Dobyns, H.F. 1981. From fire to flood: Historic human destruction of Sonoran Desert riverine oases. Ballena Press, Socorro, New Mexico. 222 pp.
- Fleischner, T.L. 1994. Ecological costs of livestock grazing in western North America. *Conservation Biology* 8(3):629-644.
- Flett, M.A. and S.D. Sanders. 1987. Ecology of a Sierra Nevada population of willow flycatchers. *Western Birds* vol. 18 no.1.
- Forsling, C.L. 1931. A study of the influence of herbaceous plant cover on surface runoff and erosion in relation to grazing on the Wasatch Plateau of Utah. U.S. Department of Agriculture Technical Bulletin 220.
- Gifford, G.F. and R.H. Hawkins. 1978. Hydrologic impact of grazing on infiltration: a critical review. *Water Resources Research*. 14:305-313.
- Gill, F.B. 1990. Ornithology. W.H. Freeman and Company, New York, New York. 660 pp.
- Gori, D., P.L. Warren, and L.S. Anderson. 1990. Population studies of sensitive plants of the Huachuca, Patagonia, and Atascosa Mountains, Arizona. Unpub. Rep. Coronado National Forest, Tucson, Arizona. 114 pp.
- Gorski, L.J. 1969. Traill's Flycatchers of the "fitz-bew" songform wintering in Panama. *The Auk* 86:745-747.
- Griffith, J.T. and J.C. Griffith. 1995. The status of the Southwestern Willow flycatcher at the upper San Luis Rey River, San Diego County, California, in 1994. Final Report to the U.S. Forest Service, Palomar Ranger District, No. 43-91U4-4-0271.
- Grinnell, J. and A.H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna No. 27. Cooper Ornithological Society, Berkeley, California.
- Hanski, I., A. Moilanen, and M. Gyllenberg. 1996. Minimum viable metapopulation size. *American Naturalist* 147:527-541.
- Harris, J.H. 1991. Effects of brood parasitism by brown-headed cowbirds on willow flycatcher nesting success along the Kern River, California. *Western Birds* 22:13-26.

- Harris, J.H., S.D. Sanders, and M.A. Flett. 1987a. The status and distribution of the willow flycatcher (*Empidonax traillii*) in the Sierra Nevada. California Department of Fish and Game Wildlife Management Branch Administrative Report 87-2., .
- Harris, J.H., S.D. Sanders, and M.A. Flett. 1987b. Willow flycatcher surveys in the Sierra Nevada. *Western Birds* 18:27-36.
- Harrison, H.H. 1979. A field guide to western birds' nests of 520 species found breeding in the United States west of the Mississippi River. Houghton Mifflin Company, Boston, Massachusetts. 279 pp.
- Hastings, J.R. and R.M. Turner. 1965. The changing mile: An ecological study of vegetation change with time in the lower mile of an arid and semiarid region. University of Arizona Press, Tucson. 317 pp.
- Hays, R.L., C. Summers and W. Sietz. 1981. Estimating wildlife habitat variables. USDI Fish and Wildlife Service. FWS 10 BS-81/47. 111 pp.
- Hendrickson, D.A. and W.L. Minckley. 1984. Cienegas - vanishing climax communities of the American Southwest. *Desert Plants* 6(3):1-175.
- Hill, A.W. 1926. The genus *Lilaeopsis*: A study in geographical distribution. *J. Linn. Soc. Bot.* 67:525-551.
- Holmgren, M.A. and P.W. Collins. 1995. Interim report on the distribution, breeding status, and habitat associations of seven federal special-status bird species and Brown-headed Cowbirds at Vandenberg Air Force Base, Santa Barbara County, California. Museum of Systematics and Ecology, Department of Ecology, Evolution, and Marine Biology, University of California: Santa Barbara, California. Environmental Report No. 3.
- Howell, S.N.G. and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford University Press, New York, New York. 851 pp.
- Hubbard, J.P. 1987. The Status of the Willow Flycatcher in New Mexico. Endangered Species Program, New Mexico Department of Game and Fish, Santa Fe, New Mexico. 29 pp.
- Hull, T. and D. Parker. 1995. The Gila Valley revisited: 1995 survey results of willow flycatchers found along the Gila River near Gila and Cliff, Grant County, New Mexico. Prepared by Applied Ecosystem Management, Inc. for the Phelps Dodge Corporation. 25 pp.
- Jackson, W., T. Martinez, P. Cuplin, W.L. Minckley, B. Shelby, P. Summers, D. McGlothlin, and B. Van Haveren. 1987. Assessment of water conditions and management opportunities

- in support of riparian values: BLM San Pedro River Properties, Arizona. USDI Bureau of Land Management, Denver, CO. 180 pp.
- King, J.R. 1955. Notes on the life history of Traill's Flycatcher (*Empidonax traillii*) in southeastern Washington. *The Auk* 72:148-173.
- Krueper, D.J. 1995. Effects of livestock management on southwestern riparian ecosystems. Pages 281-301 in D.W. Shaw and D.M. Finch (tech. coord.), *Desired future conditions for southwestern riparian ecosystems: bringing interests and concerns together*. USDA Forest Service, Gen. Tech. Rpt. RM-GTR-272.
- Kus, J. 1995. The status of the least Bell's vireo and southwestern willow flycatcher at Camp Pendleton, California, in 1995. Department of Biology, San Diego State University, San Diego, California.
- Leithead, H.L. 1959. Runoff in relation to range condition in Big Bend - Davis Mountain section of Texas. *Journal of Range Management* 12:83-87.
- Lull, H.W. 1959. Soil compaction of forest and rangelands. USDA Miscellaneous Publications 768.
- Lusby, G.C. 1979. Effects of grazing on runoff and sediment yield from desert rangeland at Badger Wash in western Colorado, 1953-73. U.S. Geological Survey Water Supply Paper 1532-I.
- Ligon, J.S. 1961. *New Mexico Birds and where to find them*. The University of New Mexico Press, Albuquerque, New Mexico.
- Martin, S.C. 1975. Ecology and management of southwestern semidesert grass-shrub ranges: The status of our knowledge. U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 39 pp.
- Mayfield, H. 1977a. Brood parasitism: Reducing interactions between Kirtland's warblers and brown-headed cowbirds. Pages 85-91, in S.A. Temple ed. *Endangered Birds: Management techniques for preserving threatened species*. University of Wisconsin Press, Madison, Wisconsin.
- Mayfield, H. 1977b. Brown-headed cowbird: agent of extermination? *American Birds* 31:107-113.
- Maynard, W.R. 1995. Summary of 1994 survey efforts in New Mexico for southwestern willow flycatcher (*Empidonax traillii eximius*). Contract # 94-516-69. New Mexico Department of Game and Fish, Santa Fe, New Mexico. 48 pp.

- McCabe, R.A. 1991. The little green bird: ecology of the willow flycatcher. Palmer Publications, Inc., Amherst, Wisconsin. 171 pp.
- McDonald, K.P., J. Snider, L.C. Peterson, M. St. Germain, and S. Staats. 1995. Results of 1995 Southwestern Willow Flycatcher surveys in the Virgin River drainage and southern Utah. Utah Division of Wildlife Resources: Cedar City, Utah. Publication No. 95-17.
- McGeen, D.S. 1972. Cowbird-host relationships. *The Auk* 89:360-380.
- Monson, G. and A.R. Philips. 1981. Annotated checklist of the birds of Arizona. The University of Arizona Press, Tucson, Arizona. 240 pp.
- Muiznieks, B.D., T.E. Corman, S.J. Sferra, M.K. Sogge, and T.J. Tibbitts. 1994. Arizona Partners In Flight 1993 southwestern willow flycatcher survey. Technical Report 52. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program, Phoenix, Arizona. 25 pp.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico., Sante Fe, New Mexico.
- Oberholser, H.C. 1974. The bird life of Texas. University of Texas Press, Austin, TX. 1069 pp.
- Orr, H.K. 1975. Recovery from soil compaction on bluegrass range in the Black Hills. Transactions of the ASAE 18:1076-1081.
- Paxton, E., J. Owen, and M. Sogge. 1996. Southwestern willow flycatcher response to catastrophic habitat loss. U.S.G.S. Colorado Plateau Research Station/Northern Arizona University report. 12 pp.
- Peterson, J.R. and M.K. Sogge. 1996. Distribution and breeding productivity of the southwestern willow flycatcher along the Colorado River in the Grand Canyon - 1996. Summary Report. Grand Canyon National Park, Grand Canyon, AZ, and National Biological Service Colorado Plateau Research Station/Northern Arizona University. 30 pp.
- Peterson, R.T. 1990. A field guide to western birds. 3rd ed. Houghton Mifflin Company, Boston, Massachusetts. 432 pp.
- Peterson, R.T. and E. Chalif. 1973. A field guide to Mexican birds. Houghton Mifflin Company, Boston, Massachusetts. 432 pp.
- Phillips, A.R. 1948. Geographic variation in *Empidonax traillii*. *The Auk* 65:507-514.

- Phillips, A., J. Marshall, and G. Monson. 1964. The birds of Arizona. University of Arizona Press, Tucson, Arizona. 212 pp.
- Pulliam, H.R. 1988. Sources, sinks, and population regulation. *American Naturalist* 132:652-661.
- Ridgely, R.S. and G. Tudor. 1994. The Birds of South America: Suboscine Passerines. University of Texas Press, Austin, Texas.
- Robbins, C.S., D. Bystrak, and P.H. Giessler. 1986. The breeding bird survey: Its first fifteen years, 1965-1979. U.S. Fish and Wildlife Service, Resource Publication 157. Washington, D.C.
- Ryder, R.A. 1980. Effects of grazing on bird habitats. Pp. 51-66 in: R.M. DeGraff and N.G. Tilghaman (compilers), Management of western forest and grasslands for nongame birds. U.S. Department of Agriculture, Forest Service General Technical Report INT-86.
- San Diego Natural History Museum. 1995. *Empidonax traillii extimus* in California. The willow flycatcher workshop. 17 November 1995. 66 pp.
- Saucedo-Monarque, E. 1990. Proyecto: Prospeccion de plantas raras en el norte de Sonora. Centro Ecologico de Sonora, Subdireccion de Investigacion, Area de Ecologia Terrestre, Hermosillo, Sonora, Mexico. 65 pp.
- Schlorff, R.W. 1990a. Petition to the State of California Fish and Game Commission to List the Willow Flycatcher as Endangered.
- Schlorff, R.W. 1990b. Status Review of the Willow Flycatcher (*Empidonax traillii*) in California. Report to the California Department of Fish and Game, Department Candidate Species Status Report 90-1, Sacramento, California. 23 pp.
- Sferra, S.J., Corman, T.E., C.E. Paradzick, J.W. Rourke, J.A. Spencer, and MW. Sumner. 1997. Arizona Partners In Flight southwestern willow flycatcher survey 1993-1996 summary report. Technical Report. Nongame and Endangered Wildlife Program. Arizona Game and Fish Department, Phoenix, AZ. 97 pp.
- Sferra, S.J., R.A. Meyer, and T.E. Corman. 1995. Arizona Partners In Flight 1994 southwestern willow flycatcher survey. Final Technical Report 69. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program, Phoenix, Arizona. 46 pp.
- Shafer, C.L. 1990. Nature Preserves, Island Theory and Conservation Practice. Smithsonian Institution Press, Washington D.C, 189 pp.

- Sheridan, T.E. 1986. Los Tucsonenses: The Mexican community in Tucson. 1854-1941. University of Arizona Press, Tucson. 327 pp.
- Skaggs, R.W. (1996). Population size, breeding biology, and habitat of willow flycatchers in the Cliff-Gila Valley, New Mexico 1995. Final Report. New Mexico Department of Game and Fish: Glenwood, New Mexico. 38 pp.
- Smith, D.R. 1967. Effects of cattle grazing on a ponderosa pine-bunchgrass range in Colorado. USDA Technical Bulletin 1371.
- Sogge, M.K. 1995a. Southwestern willow flycatcher (*Empidonax traillii extimus*) monitoring at Tuzigoot National Monument. 1995 progress report to the National Park Service. National Biological Service Colorado Plateau Research Station/Northern Arizona University, Flagstaff, Arizona. 20 pp.
- Sogge, M.K. 1995b. Southwestern willow flycatcher surveys along the San Juan River, 1994 - 1995. Final report to the Bureau of Land Management, San Juan Resource Area. National Biological Service Colorado Plateau Research Station/Northern Arizona University, Flagstaff, Arizona. 27 pp.
- Sogge, M.K. 1995c. Southwestern willow flycatchers in the Grand Canyon. Pages 89-91, in E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran, and M.J. Mac eds. Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. Department of the Interior, National Biological Service, Washington, DC.
- Sogge, M.K., R.M. Marshall, S.J. Sferra and T.J. Tibbitts. 1997. A southwestern willow flycatcher natural history summary and survey protocol. National Park Service Technical Report NPS/NAUCPRS/NRTR-97/12. 39 pp.
- Sogge, M.K. and T.J. Tibbitts. 1992. Southwestern willow flycatcher (*Empidonax traillii extimus*) surveys along the Colorado River in Grand Canyon National Park and Glen Canyon National Recreation Area. National Park Service Cooperative Park Studies Unit/Northern Arizona University, Flagstaff, Arizona. 43 pp.
- Sogge, M.K. and T.J. Tibbitts. 1994. Distribution and status of the southwestern willow flycatcher along the Colorado river in the Grand Canyon - 1994. Summary Report. National Biological Survey Colorado Plateau Research Station/Northern Arizona University, Flagstaff, Arizona. 37 pp.
- Sogge, M.K., T.J. Tibbitts, and S.J. Sferra. 1993. Status of the southwestern willow flycatcher along the Colorado River between Glen Canyon Dam and Lake Mead - 1993. Summary Report. National Park Service Cooperative Park Studies Unit/Northern Arizona University,

- U.S. Fish and Wildlife Service, and Arizona Game and Fish Department., Flagstaff, Arizona. 69 pp.
- Sogge, M.K., T.J. Tibbitts, C. van Riper III, and T. May. 1995. Status of the southwestern willow flycatcher along the Colorado River in Grand Canyon National Park. National Biological Service, Colorado Plateau Research Station Northern Arizona University, Flagstaff, Arizona. 26 pp.
- Spencer, J.A., S.J. Sferra, T.E. Corman, J.W. Rourke, and M.W. Sumner. 1996. Arizona Partners In Flight 1995 southwestern willow flycatcher survey. Technical Report 97, March 1996. Arizona Game and Fish Department, Phoenix, Arizona. 69 pp.
- Stiles, F.G. and A.F. Skutch. 1989. A guide to the birds of Costa Rica. Comstock, Ithaca, New York. 364 pp.
- Stransky, K. 1995. 1995 Field survey by the Colorado Division of Wildlife: Southwestern Willow Flycatcher (*Empidonax traillii extimus*).
- Tibbitts, T.J., M.K. Sogge, and S.J. Sferra. 1994. A survey protocol for the southwestern willow flycatcher (*Empidonax traillii extimus*). Technical Report NPS/NAUCPRS/NRTR-94/04. National Park Service Colorado Plateau Research Station, Flagstaff, Arizona. 24 pp.
- Tromble, J.J., K.G. Renard, and P.P. Thatcher. 1974. Infiltration rates for three soil-vegetation complexes. *Journal of Range Management* 27:318-321.
- Unitt, P. 1984. The birds of San Diego County. *San Diego Society of Natural History*.
- Unitt, P. 1987b. *Empidonax traillii extimus*: An endangered subspecies. *Western Birds* 18:137-162.
- U.S. Fish and Wildlife Service. 1989. Notice of review: animal candidate review for listing as endangered or threatened species. *Federal Register* 54:554.
- U.S. Fish and Wildlife Service. 1993. Notice of 12-month petition finding/proposal to list *Empidonax traillii extimus* as an endangered species, and to designate critical habitat. *Federal Register* 58:39495-39522.
- U.S. Fish and Wildlife Service. 1995. Final rule determining endangered status for the southwestern willow flycatcher. *Federal Register* 60:10694-10715.
- United States Department of Interior. 1997. Endangered and threatened wildlife and plants: determination of endangered status for three wetland species found in southern Arizona and northern Sonora, Mexico. *Federal Register* 62(3):665-689.

- Walkinshaw, L.H. 1966. Summer biology of Traill's flycatcher. *Wilson Bulletin* 78:31-46.
- Warren, P.L., L.S. Anderson, and P.B. Shaffroth. 1989. Population studies of sensitive plants of the Huachuca and Patagonia Mountains, Arizona. Unpub. Rep. to Coronado National Forest, Tucson, Arizona. 99 pp.
- Warren, P.L. 1991. Recovery of Lilaeopsis schaffneriana ssp. recurva at San Bernardino National Wildlife Refuge. Unpub. Rep. for the USDI Fish and Wildlife Service, Phoenix, Arizona. 6 pp.
- Warren, P.L., D.F. Gori, L.S. Anderson, and B.S. Gebow. 1991. Status report for Lilaeopsis schaffneriana ssp. recurva. USDI Fish and Wildlife Service, Arizona Ecological Services Field Office, Phoenix. 30 pp.
- Warren, P.L. and F.R. Reichenbacher. 1991. Sensitive plant survey of Fort Huachuca, Arizona. Unpub. Rep. for the U.S. Army, Fort Huachuca, Arizona.
- Water and Environmental Systems Technology, Inc. 1994. San Pedro hydrologic system model, U.S. Bureau of Reclamation scenarios, November, 1994. Report to the Bureau of Reclamation, Phoenix, Arizona.
- Webb, R. H. and J.L. Betancourt. 1992. Climatic variability and flood frequency of the Santa Cruz River, Pima County, Arizona. U.S. Geological Survey Water Supply Paper #2379.
- Wheelock, I.G. 1912. Birds of California: an introduction to more than three hundred common birds of the state and adjacent islands. A.C. McClurg and Company, Chicago, Illinois.
- Whitfield, M.J. 1990. Willow flycatcher reproductive response to brown-headed cowbird parasitism. Masters Thesis, California State University, Chico, California State University, Chico, California.
- Whitfield, M.J. 1993. Brown-headed cowbird control program and monitoring for willow flycatchers, South Fork Kern River, California. Draft report to California Department of Fish and Game, Contract #FG 2285., Weldon, California. 11 pp.
- Whitfield, M.J. 1994. A brown-headed cowbird control program and monitoring for the southwestern willow flycatcher, South Fork Kern River, California, 1994. Prepared for the California Department of Fish and Game. Kern River Research Center, Weldon, California. 12 pp.
- Whitfield, M.J. 1995. Results of a brown-headed cowbird control program for the southwestern willow flycatcher. in S. Rothstein, S. Robinson, S. Sealy, T. Cook, and J.M.N. Smith eds. The ecology and management of cowbirds. University of Texas Press, Austin, Texas.

- Whitfield, M.J. and C.M. Strong. 1995. A brown-headed cowbird control program and monitoring for the southwestern willow flycatcher, South Fork Kern River, California. California Department of Fish and Game, Bird and Mammal Conservation Program Report 95-4, Sacramento, California. 17 pp.
- Wilcox, B.A. and D.D. Murphy. 1985. Conservation strategy: The effects of fragmentation on extinction. *American Naturalist* 125:879-887.
- Willard, F.C. 1912. A week afield in southern Arizona. *The Condor* 14:53-63.
- Willet, G. 1912. Birds of the Pacific slope of southern California. *Pacific Coast Avifauna* 7.
- Willet, G. 1933. A revised list of the birds of southwestern California. *Pacific Coast Avifauna* 21.